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PROPOSED RAILWAYS IN CHINA.

THE opposition of Chinese bigotry and timidity, for many years past, to the construction of railways in that vast and populous country has repeatedly been exposed. A quarter of a century ago, the projected line from Shanghai to Soochow, undertaken by an English company and supported by the mercantile community of Shanghai, was stopped by the Chinese government; and on the line actually constructed from Shanghai to Woo-sung the rails were taken up, so that it was never opened for traffic. Only a few months ago, the young emperor was persuaded to forbid the extension of the short Tientsin line, in North China, to Tungchow, a few miles from Pekin, which had been approved by the most powerful viceroys, with the support, it is believed, of Prince Chun, the emperor's father, and of the empress dowager. It is a great surprise, therefore, and it seems to be very good news, that an imperial decree has been issued ordering the construction of a trunk line from Pekin across the country to Hankow, a treaty port on the Yangtsze, and the greatest trade mart in Central China. The foreign trade of Hankow last year amounted to about eleven millions sterling. The decree may be taken as the final decision of the emperor and his government that railways are a necessity for China, and that their construction is to take place with such speed as circumstances, pecuniary and other, will admit.

A railway from Pekin to Hankow, in a straight line nearly seven hundred miles, is such a large undertaking that it is evidently no mere experiment, but the beginning of what may be called a "Grand Trunk Line," which is to be carried through the middle of China from north to south. It starts at the capital of the empire, and will run almost due south to Hankow, on the north bank of the Yangtsze Kiang. Before this great river can be crossed at that place another Forth Bridge will be required, for the Yangtsze Kiang is there a mile wide, the same span as the Firth of Forth at Queensferry.

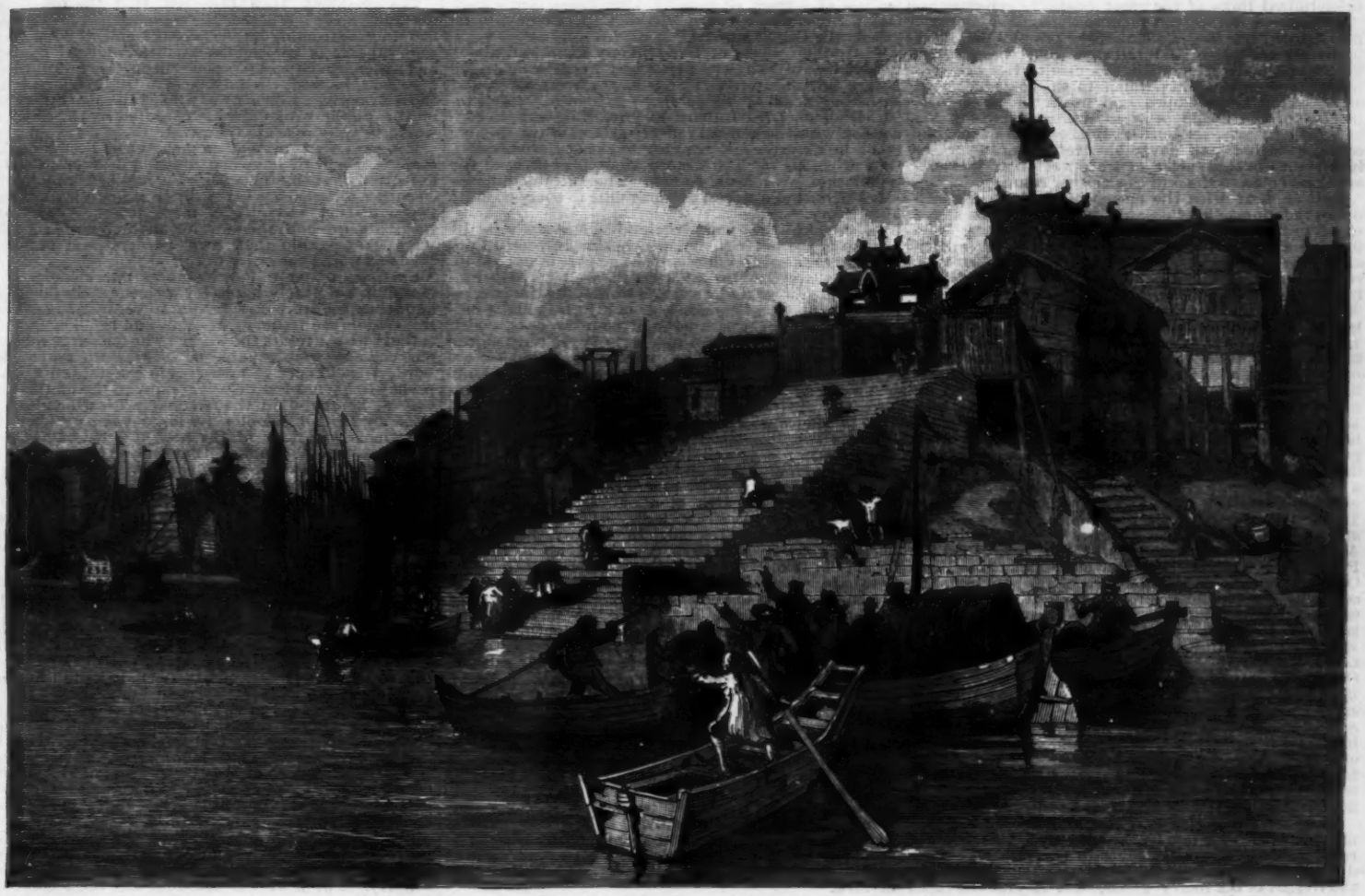
About half way between Pekin and Hankow the railway will have to cross the Hoang-ho, or Yellow River, a stream that has earned for itself the name of "China's Sorrow," from the number of times it has flooded the country it passes through. There will, no doubt, be some engineering difficulties at this point; but when they are surmounted and the line made it will, like the railways in India, be the means of preventing famine, or at least help to avert the severer forms of distress, by giving a quick and ample means of forwarding food supplies when a scarcity occurs from the accident of the river overflowing its banks.

Taking the line so far as it has been sanctioned by the late imperial decree, it will, when made, be of great advantage from a commercial point of view. Most of our first lines of railway followed the course of the existing canals; and, curiously enough, this first line in China does the same. It will follow the line of the Grand Canal, but diverge westward from it as it comes south. The Grand Canal tapped the commerce of the Yangtsze Kiang at Chin-Kiang, and the railway will tap it at Hankow. As the Great River is a busy stream of commerce from east to west, across the whole breadth of the empire, the goods traffic on the railway ought to be large. The passenger traffic on Chinese railways is a matter there need be no doubt whatever about. The steamboats on the river have already supplanted the antique junk, the one is deserted for the other, and the steamers are crowded by those who have to travel; and we may be sure that the Chinaman will in the same way appreciate the advantages of the railway.

The city of Hankow, with the adjacent towns of Wu-shang, the capital of the province of Hupeh, on the opposite south bank of the Yangtsze Kiang, and Hanyang, on the right bank of the Han River, is 582 geographical miles west of Shanghai, occupying a central position of great importance to commerce with the heart of China. Our view of the confluence of the Han River with the Yangtsze Kiang, just below the two Han towns, is from a sketch by Mr. W. Simpson, taken on the "bund," or river embankment, in front of the British consulate; Wu-shang, across the Yangtsze Kiang, is seen in the distance.

It shows little of the extent of Hankow, which continues two miles and a half on flat ground up the river that gives it its name; while Hanyang, an old half-ruined fortified town, stands on a precipitous range of hills. The Pagoda Hill commands a wide prospect of the meeting river waters, the immense plain to the north, sometimes flooded in summer, and the hills that rise on the banks of the Yangtsze Kiang some miles above the city. Hankow itself has a population of 600,000, and that of the three cities altogether is estimated at one million. The first European official visit to Hankow was that of Lord Elgin in 1858; but in 1861 this town was visited by Admiral Sir James Hope and Sir Harry Parkes, was declared a treaty port open to foreign trade, and a British settlement was formed here, which is governed by its own municipal council, like Shanghai.

It has, to a certain extent, superseded Canton as a great shipping port for the teas, cotton, silk, oils, drugs, and other produce of Southern China, and for the import of cotton and woolen manufactures. Hankow, indeed, being an inland port for seagoing vessels, is a formidable rival to the coast ports, and may become still more important by the introduction of steamboats on the Upper Yangtsze Kiang, from I-chang to Chung King. We lately noticed a book, "Through the Yangtsze Gorges," by Mr. Archibald John Little, which gives an exact account of this project of inland steam navigation and of the picturesque mountain and river scenery above I-chang, which is a thousand miles from the sea. No country in the world except North America by the Mississippi and Missouri and South America by the La Plata and its tributaries has such great natural facilities as China for traffic with its far inferior; and if Hankow, commanding the navigation of the Yangtsze Kiang from east to west, is to have railway communication also with the north and south, its commercial destiny will be magnificent indeed. It is not impossible that the grand trunk railway of China may some day be carried onward to Canton.—*Illustrated London News.*



PROPOSED RAILWAYS IN CHINA—HANKOW, JUNCTION OF THE HAN RIVER WITH THE YANGTSZE KIANG.

CIVIL ENGINEERING IN THE BRITISH COLONIES.

AT a recent meeting of the Institution of Civil Engineers, the president, Sir John Coode, K.C.M.G., delivered an inaugural address, it being the first occasion of his occupying the chair at an ordinary meeting since his election as president. After referring to the growth of the institution, from about six hundred when he joined it as a member in 1849, to approximately six thousand at the present time, he alluded to the visit of the American engineering societies soon after the close of the last session, and the leading part taken by the Institution in their reception and entertainment.

When considering the question of a topic for his address, it appeared to him that the experience gained during three lengthened professional visits to distant parts of the British empire might not be unsuitably drawn upon, the visits involving journeyings of more

than 75,000 miles. The text of his subject was, "British Colonies as Fields for the Employment of the Civil Engineer." By the term colony was strictly meant a country, or portion of a country, inhabited by a people who had gone forth from their mother land and had made that country their home, though remaining more or less directly under the government of the country from which they or their ancestors had originally emigrated.

There might be said to be British dependencies, held mainly for strategic purposes, in which the British element in the population was very small, such as Gibraltar, Malta, Cyprus, and Heligoland; dependencies under the British crown chiefly used as trading stations, but also serving as coaling stations, and for repairing steamers of the mercantile marine, or ships of the royal navy, such as Singapore and Hong Kong; colonies which were exporters of their own produce on a large scale, such as the West India Islands, Mauritius, and Ceylon; and colonies proper, as Canada, Australia, South Africa, and New Zealand. The keynote to the colonial question was best represented by the single word "transport." Wherever there was trade, there would of necessity be a demand for the means of transport, there would be found a need for the works of the civil engineer. While the population of the world had increased by a little less than ten per cent. between 1870 and 1880, the increase in transport within the same period had been fully fifty-three per cent. The connection was obvious between transport and the several engineering works comprehended under the construction of railways, tramways, roads, canals, harbors, docks, steamships, locomotives, bridges, viaducts, aqueducts, tunnels, water works, gas works, sewage works, and irrigation channels; breakwaters and lighthouses might be included within this same category, and he ventured to affirm that this factor of transport pervaded the domain of electric telegraphy. Harbors and docks assumed a special importance in connection with our colonies. As respected external trade, they formed the terminal links of the great chains of communication which served to bind them to the mother country. As regarded our larger colonies, the practice had been to extend the roads and railways from the seaports back into the interior, with the result that the land lines of communication parallel to the coast had been as yet but little developed, and much the larger proportion of the traffic between different parts of the same colony was sea-borne. Hence in most of our colonies, harbors and navigable rivers assumed greater importance in the matter of transport than was generally assigned to them in the mother country.

Dealing next with the means of reaching the colonies, the question of oceanic transport by means of steam navigation was of paramount importance. The first crossings of the Atlantic by steam propulsion alone were accomplished by the Sirius, of 700 tons, starting from Cork, and the Great Western, of 1,340 tons, from Bristol, both reaching New York on April 23, 1838, the time occupied by the latter vessel having been fifteen days and six hours. It was in this same year that the English government first invited tenders for the conveyance of mails to the American continent by steam, which led to the establishment of the Cunard line, of which the first vessel, the Britannia, of 1,155 tons and 850 horse power, left Liverpool on July 4, 1840, and took fourteen days to complete the voyage to Halifax. At the present time the passage between Liverpool and New York had been accomplished within six days. The Peninsular and Oriental Company afforded a striking example of the progress of ocean steam navigation between the United Kingdom and the colonies. The first contract with the government for the conveyance of mails by sea-going steamers was entered into in August, 1837, by the company at that time called the Peninsular. The steamers ran from Falmouth to Vigo, Oporto, Lisbon, Cadiz, and Gibraltar. In 1840, the company was expanded into the Peninsular and Oriental, and the mails were conveyed by steamer from England to Alexandria. In September, 1842, the service was extended to India. A further contract was undertaken by the company in 1844 to carry the mails to Ceylon, Singapore, and Hong Kong, and from March, 1852, a service had been established with Australia, and conducted with punctuality, safety, high speed, and comfort. Meanwhile the tonnage of the vessels had increased from 600 to 800 fifty years ago, to 2,500 tons of 3,500 horse power twenty-five years ago, and to 6,300 tons in the latest additions to the fleet, which maintained a regular sea-going speed of 15 to 16 knots an hour on the 12,000 miles run from London to Australia.

This increase of size and power had been specially marked within the last five or six years. One result of recent improvements in steamship building was a reduction in the cost of ocean transport. The cost of the freight of the heavy goods, such as manufactured iron, say to Sydney, a distance of nearly 12,000 miles from England, was about £35 per ton twenty years ago, whereas recently it had been as low as £1 10s. a ton, or a little more than ¼d. per ton per mile, and the saving in distance by the Suez Canal route, as compared with the route by the Cape, was only about one-ninth of the whole distance. Sir John Coode then referred to two recent examples of modern passenger steamships—the Teutonic, belonging to the White Star Line, 582 ft. in length, with a gross tonnage of 9,685, provided with accommodation for 1,200 passengers, and, by arrangement with the Admiralty, intended to carry in time of war twelve five inch guns, having a maximum range of over five miles.

The other example was the City of Paris, belonging to the Inman and International Steamship Company. This was the only vessel which had hitherto made the passage between New York and Liverpool in less than six days, her mean speed on a voyage in May last having been 23·73 statute miles an hour. This vessel was of 10,500 tons burden and 18,000 horse power, being eight times the tonnage and forty times the horse power of the Great Western. She had fifty-four furnaces, and her boiler tubes exceeded thirteen miles in length. With regard to the possible future development of steam navigation, the question of hydraulic propulsion by jets of water at a high velocity was engaging the attention of many engineers.

The president then entered into the statistics of the chief engineering works which had been, or were being, carried out in British colonies, and the scope which existed in those colonies for the future employment of civil engineers, giving their position, general configuration, and physical features, area and population, climate, industrial products, and mineral wealth; and public works, whether executed, in progress, or contemplated in the immediate future. Canada, the largest of the colonial dependencies of Great Britain, had an area of 3,610,000 square miles, of which 140,000 square miles were covered with water, and the system of inland navigation was the largest in the world. The St. Lawrence alone, in conjunction with the great lakes, afforded unbroken water communication to Port Arthur and Duluth from Liverpool. The total length of railways in the Dominion was about 14,000 miles, and the area of territory in the Dominion per lineal mile of railway was in the proportion of 258 to 1. Although completed thirty years ago, the Victoria bridge across the river St. Lawrence still remained one of the finest engineering works of the last half century; and the Ship Canal in the St. Lawrence, 27½ ft. deep, completed twelve months ago, had a very important bearing upon the commercial prosperity of the Dominion, enabling merchant steamships of the largest class to reach Montreal. Two large graving docks had been constructed, one at Esquimalt, in British Columbia, and the other at Halifax, in Nova Scotia, while a ship railway, seventeen miles long, was being laid for the transport of vessels across the isthmus which connected Nova Scotia with New Brunswick. In the West Indies, the harbor of Castries, in St. Lucia, had been selected as the chief coaling station for the British fleet. When finished, the depth of water at low tide alongside the quay would be 27 ft. The harbor would become of very great importance in the event of the completion of the Panama or the Nicaragua canal. In Europe, Heligoland was the smallest of the British possessions, its area being about one-quarter square mile, and Gibraltar, Malta, and Cyprus, within the Mediterranean Sea, were held for strategic purposes only. In Southern Africa there were at the present time only two British colonies, the "Cape Colony" and "Natal." The imperial government had just granted a charter to the British South African Company, to develop the resources of a tract of country four times larger than Great Britain, northward of the Cape Colony, to be called "British Zambesia."

The public works of Cape Colony comprised about 1,700 miles of railway, being one lineal mile to 126 square miles of territory; harbors, a breakwater, and a graving dock at Table Bay; two iron jetties, together about 1,700 ft. long, at Port Elizabeth, in connection with the general railway system of the colony; and a breakwater and training banks at East London. Of the colony of Natal, more than four-fifths of the population were Zulu Kaffirs. The railway mileage was 220 open, equivalent to one mile to every 86 miles of territory.

In Ceylon, the most noticeable feature was the growth of the tea industry, which had increased from the insignificant production and export of only 15 lb. sixteen years ago to 32,500,000 lb. in 1888. Of railways, which were all owned and worked by the government, there were 180 miles, or one lineal mile of railway for each 137 square miles of country, upon which the net profit had risen to nearly 11 per cent. on the outstanding capital. The harbor of Colombo, 500 acres in extent, sheltered by a breakwater 4,200 ft. long, was being deepened to 28 ft. and upward. At Singapore, the capital of the Straits settlements, a sea wall 3,000 ft. long was in course of execution, and at Hong Kong, which like Singapore was the emporium of a large trade, a sea wall rather more than 1¾ miles in length, and founded in about 30 ft. of water, was about to be constructed parallel to and 250 ft. seaward of the existing wall. An area of about 60 acres would be reclaimed between these walls, whereon high class buildings would be erected. In New Zealand 1,750 miles of railway had been completed up to the end of March, 1888, giving one lineal mile of railway to 59 square miles of territory. Breakwaters and training banks were being constructed for the improvement of the entrance of the River Buller at Westport, and similar works were in progress at Greymouth.

A new graving dock had lately been completed at Auckland, 500 ft. long and 80 ft. wide, with a depth of 33 ft. of water over the sill at spring tides. Otago harbor entrance had been improved, and a harbor created at Lyttleton, near Christchurch, inclosing an area of about 112 acres, with jetties and wharves having a length of berthage of 11,000 ft., with lines of railways in connection with the general system of the island. The depth of water within the harbor varied from 19 ft. to 25 ft. at low water. In Tasmania 440 miles of railway had been opened at the end of 1887, being one lineal mile of railway to 55 square miles of country. Sir John Coode then referred to Australia, treating it first as a whole, and afterward dealing separately with the five colonies into which it was divided.

It was about six-sevenths of the size of Canada, and only about one-fifth smaller than the continent of Europe. An index of its magnitude was to be found in the size of the catchment basin of the River Murray and its tributaries, the area of which was 510,000 square miles, or nearly six times greater than Great Britain. In Western Australia, with a population of only one inhabitant to 25 square miles, there were 450 miles of railway, or one lineal mile for each 2,375 square miles of territory. In South Australia, at the end of 1888, there had been constructed 1,820 miles of railway, or one mile to 496 square miles of land. At Port Adelaide there was a total wharf frontage of about 13,000 ft., and the channel leading up to the port from the sea had been deepened from 9½ ft. to 22 ft. at low water. The works for the water supply of Adelaide were of a very extensive character, and when completed would include a storage reservoir of 2,760,000,000 gallons capacity.

Victoria, the smallest colony in Australia, had 2,200 miles of railway in operation at the end of 1888, being one lineal mile to 40 square miles of area. As an instance of the wonderful growth of the city of Melbourne, the capital of the colony, the president stated that little more than fifty years ago a corner plot of land, near the center of the city, was sold from a tree stump as a rostrum for 45*l.*, and that the same plot, with the buildings upon it, had just been valued at 493,500*l.* Until recently, the navigation from the bend of the bay, by the River Yarra Yarra to the city, a distance of 6¾ miles, was through a narrow, tortuous channel.

This had been greatly improved by training works and the cutting of a canal, and the navigation was now through a channel 5½ miles in length, and when completed would have a depth of 20 ft. and bottom width of 150 ft. The storage capacity of the Yan Yean reservoir, for the water supply of Melbourne, was 6,400,000 gallons, the expenditure on the system had exceeded 2,500,000*l.*, and further works were in progress. Irrigation on a large scale had been fostered by the government of Victoria, the area intended to be irrigated amounting to nearly 1,250,000 acres. In New South Wales, at the end of 1888, 2160 miles of railway were open, being one lineal mile to 144 square miles of country.

The length of the great bridge over the Hawkesbury River, which formed the last link in the continuous railway system between the principal cities of the four colonies of South Australia, Victoria, New South Wales, and Queensland, was 2,900 ft. between the abutments, and the foundations of the several piers, six in number, were carried to depths varying from 101 ft. to 162 ft. below high water level. The president then referred to the recently constructed graving dock on Cockatoo Island, in the harbor of Sydney, 600 ft. long and 84 ft. wide, to the Macquerie lighthouse at the entrance to Port Jackson, to the water supply of Sydney, and to the works at Newcastle at the mouth of the Hunter River, the great coal shipping port of the colony.

In Queensland the returns up to the end of 1887 showed that 1,770 miles of railway were open, or one lineal mile to 378 miles of area. River improvements had been effected in the channel leading up to Brisbane, at the Fitzroy River from the sea up to the town of Rockhampton, at the entrance of the Pioneer River, and also at the entrance to Norman River in the Gulf of Carpentaria. As an instance of the mineral wealth of this colony, the Mount Morgan mine, near Rockhampton, was now turning out gold to the value of 128,000*l.* per month, of which 28,000*l.* went in working expenses, and the balance in dividends to the shareholders.

The president then observed that the questions naturally arose: Whether the colonies had been justified in constructing public works? and whether they were capable of bearing the financial obligations they had thereby imposed upon themselves? To these questions, he said, circumstances warranted a reply in the affirmative; taken as a whole, the market value of the public works already executed by the colonies would be fully equal to their cost.

The earlier settlers had in many cases been brought face to face with large and pressing demands, for the execution of such public works as had been absolutely essential for securing ready inter-communication between district and district, more especially between the seaboard and the interior, involving roads, railways, etc., within their own borders, and between themselves and the outer world.

Further, in not a few instances our colonies had found it absolutely necessary to incur a considerable annual expenditure on subsidies to ocean-going steamships, to insure frequent, regular, and rapid communication with the rest of the world. The question whether our colonies were capable of bearing their financial burdens could only be answered in general terms; but perhaps the most conclusive reply in the affirmative was to be found in the readiness with which invitations by British colonies for large loans were met in the "money market" of the city of London. It was doubtless not overlooked that in the larger colonies vast areas of land were yet unappropriated, and formed so much capital in reserve.

Moreover, in the case of some of the government lands occupied by squatters, the rentals were subject to a percentage of increase periodically. Further, the financial position, and consequently the spending power of the colonies, was favorably affected by the present low rate of interest obtainable for capital in this country. Many were now able to raise loans at 3½ per cent., which not so very long ago found it necessary to offer 6 per cent.

While our own country had for the last 300 years been steadily building up a great empire by the acquisition of colonial possessions, it was only within the last decade that any other European state had taken action of importance in the matter of colonization. It was also worthy of remark that, within those portions of the world possessing such a climate as to admit of the employment of white labor upon outdoor operations, there was not now a single region of any magnitude available for colonization, and that no inconsiderable part of the area of the globe was under the imperial ægis of Britain.

In concluding, Sir John Coode spoke of the capabilities and possibilities yet to be developed by the civil engineer, whether in the colonies or in the mother country. The field was indeed a vast one; great advances had recently been made, and were still being made, in every branch of engineering. Notwithstanding, he would be rash who would venture to prescribe a limit to engineering achievements. He was convinced that as long as the present dispensation might last, so long would there be a continuous progress in the science and practice of every branch of labor in the field appertaining to the civil engineer. Neither to the engineer, nor indeed to any other disciple of natural science, would it seem to have been announced, "Thus far shalt thou go, but no further."

SERPOLLET'S STEAM TRICYCLE.

SERPOLLET'S instantaneous steam generator was applied to various apparatus exhibited in classes 52, 61 and 65, at the exposition, and in the special pavilion of the manufacturers, opposite the Jena bridge. We shall not again go into the details of the essential arrangements of this invention, but shall examine the applications already made of it, and which fully justify the hopes that were entertained of it at the time of its first appearance.

It will be remembered that the element of vaporization consists of a long flattened tube having between its interior sides a space of a few tenths of a millimeter, in which is produced, without calefaction, a continuous vaporization of the water injected by a compression pump. Owing to the immediate generation of steam at the requisite pressure, and in measure as it is needed, the boiler requires no storage of water nor any steam reservoir. For these there is substituted a reserve of heat units stored up in the metallic mass of the generator, in order to obtain a great elasticity of

production and to increase the resistance, and also the duration of service of the vaporizing elements. These conditions as a whole concur to obtain the result sought; that is, the radical suppression of the dangers of explosion.

In the present boilers the vaporizing elements are of rolled copper. The spirally wound tube is provided on each side with ribs designed to facilitate the exchange of temperatures, and, at the same time, to prevent the tube's tendency to straighten out under the intense action of the heat. Each tube is 2 meters in length and 0·09 meter in width. The width of the capillary space is 0·42 millimeter. It has an internal surface of 16 square decimeters, and its weight is 33 kilogrammes for a production of steam corresponding to one horse. These apparatus are tested to 100 atmospheres and registered at 94. They are not provided with any of the safety apparatus required for ordinary boilers. The tube is spirally arranged in order that it may be easily placed in a furnace. The water is introduced at one side (that which is the most heated), and the steam is received at the other extremity. For powers greater than that of one horse, a sufficient number of elements are superposed one above another and connected in tension through tubulures. The feeding is effected through an injection at the hottest part of the tube—that nearest the fire. The object of this method of feeding is to bring about a considerable fall of temperature, whence results an excellent utilization of the heat, its absorption by the tubes being in direct ratio of such fall. Another result of this arrangement is the preservation of the tubes. In fact, those that are most exposed to the fire receive the whole quantity of water that is to be vaporized by the others.

To prevent the metal from being burned during stoppages, there is arranged back of the furnace an orifice that communicates with the chimney through a special conduit. The production of steam is arrested by cutting off the supply of water. This is effected through the closing of a cock whose key is connected with the rod of the damper that directs the gases either through their internal conduit, which is the position of running, or through a false conduit, which is the position of stoppage. This arrangement gives very excellent results.

As it was not possible to set in operation the apparatus exhibited in class 52 and class 60 in the machinery palace, a part of the applications already realized were collected in the manufacturers' special pavilion. These comprised, in the first place, an electric installation of one horse power. The generator consisted of a single tube of the type shown in Fig. 2. Its vaporizing power was 20 kilogrammes per hour, and the grate surface measured 7 square decimeters. The motor was horizontal. The diameter of the cylinder was 60 millimeters, and the stroke of the piston 90 millimeters.

With an admission of 70 per cent., and a velocity of 300 revolutions, the consumption of steam per hour was 15 kilogrammes for a work of 75 kilogrammeters. A small centrifugal for a regulator modified the action of the pump in such a way as to keep the speed of running constant. When the motor was doing a minimum work, the heat of the furnace became stored up in the metal of the generator, whence it was afterward drawn to conquer the maximum stresses that might be opposed to the motor. The generator was set in operation through an injection of water by means of a hand pump, and the feeding was afterward done through an automatic pump.

Another installation of the same power was applied to a rotary pump. Its generator consisted of two tubes grouped in tension. As the feeding was automatic, the apparatus could be left to itself for several hours. The amount of coal used was 4 kilogrammes per hour.

There was also exhibited a 3 horse power generator which supplied a power hammer. The propulsion of vehicles on roads was one of the first applications that was made of the new generator. In this direction, the results obtained by Mr. Serpollet have been most satisfactory, and we herewith represent a tricycle for two persons that the house exhibited, and in which the generator consisted of two superposed tubes coupled in tension. As the feeding of the fuel is done automatically after it has been lighted, and as the generator can operate without surveillance, it has been possible to place the latter in the rear. On this account, all that the tricyclist has to occupy himself with is the

FIG. 2.—VAPORIZER OF THE SERPOLLET STEAM GENERATOR.

direction and speed to give to the vehicle. The speed is regulated by the same hand that steers. As the bar of the steering wheel is rotary, it maneuvers a cock that permits of a return to the cistern of a certain part of the water forced by the feed pump. According to the opening of this cock, more or less water enters the generator, so that the pressure becomes correspondingly modified.

The setting in operation is effected as in stationary motors; that is to say, at the start, a small special pump is maneuvered for an instant by hand. The stoppage is effected through a return of all the water to the cistern, and through the action of a brake with a pedal.

Owing to its arrangement, the machine is capable of tripling or quadrupling its power, and the vehicle has been able to ascend gradients of 15 centimeters per meter. The supply of coal carried is 60 kilogrammes, and the water cistern holds 40 liters. The consumption is from 8 to 10 kilogrammes per hour.

Upon a slightly frequented and well kept up road, a speed of 25 kilometers, or more, per hour may be maintained; but, as well known, such speed is limited by the difficulty of steering with security. So, we may consider from 10 to 15 kilometers per hour as a mean speed. The vehicle is noiseless and emits neither smoke nor steam. A small box receives the hot cinders, so that they may not drop on the roadway.—*Revue Industrielle.*

THE BROWN WIRE GUN.

THIS gun consists essentially of an inner tube made of longitudinal segments, or steel bars or staves, put together somewhat as barrel staves, and wound with steel wire, under a tension that will produce such a compression between the segments at their inner surface that they will not begin to open under ordinary powder pressures. The entire gun is then incased in a metal jacket to protect the wire from the fire of rapid-firing guns, the trunnions being attached to this outer jacket.

The gun having been thus far finished is then bored out to receive a lining tube similar to those used in the Russian service.

The steel segments will be rolled from ingots of the best crucible steel, and will be required to have an elastic limit of 32 tons per square inch. Elongation after rupture not to be less than 12 per cent. for 6 inch specimen.

These segments will be given the temper of an ordinary sword blade, which may be done without distortion, by chilling between properly constructed chilling plates, as is now practiced in the largest saw manufactory in this country. The temper may then be drawn in an oil bath.

For the 10 inch gun, 152 such segments will be used, having a mean thickness of 0.37 inch. Each double stave will weigh about 400 lb. (two staves being rolled at a time); this mass of metal can be readily handled, rolled, forged and tempered.

The several segments, being brought into position so as to form a tube, are held by clamps, until the breech and muzzle ends are turned down and threaded to receive a breech and muzzle nut. These nuts are screwed on hot, the proper allowance being made for shrinkage, so that, after winding, the tension of the wire and nuts shall be the same. The entire segmental tube is then turned down to a straight taper.

The core thus formed will then be wound with steel wire, under a tension of 40 tons per square inch, from breech to muzzle between the nuts. As the wire to be used will be No. 16 gauge, 0·065 inch in diameter, this tension will correspond to 300 pounds upon the wire. This wire can readily be obtained in suitable lengths, having a tensile strength of 268,000 pounds per square inch and an elastic limit of 199,000 pounds per square inch. That is, a wire which will require a weight of 600 pounds or thereabouts to stretch it sufficiently to give it a permanent elongation, and 800 pounds to break it.

Manufacturers have informed the company that they can furnish wire of this quality at the rate of fifty tons per day. This may seem a very high grade of wire when compared with that used in the Woodbridge gun, but it must be remembered that the latter was a very large wire as compared with this, and it is a well-known fact that the smaller the wire drawn from the same ingot, the higher the physical qualities. A higher grade of wire than that proposed to be used in the construction of the Brown gun is used every day in piano manufacture. All wire used in the gun must be sufficiently tough to be wound around its own diameter without crack or fracture.

The tension will be maintained and regulated by means of an electric windlass and regulator, similar to those used in winding armatures, etc., for electric dynamos. Space will not admit of a description of this device; it is sufficient to say that a very simple contrivance will regulate the tension to a small fraction of a pound.

The gun is then covered with a coat of waterproof paint, and the trunnion and chace jacket screwed on. These jackets take up no part of the circumferential stress, the former being merely a means of attaching the trunnions, and the latter a protection against small projectiles.

The gun is finally bored out and fitted with a lining tube, in either one or two pieces, as now practiced in Russia and England.

It should be remembered that this tube is merely a lining tube, intended to protect the segmental tube from scoring and to take the rifling. It is not inserted until after the winding has been completed.

After reading a description of this gun and examin-

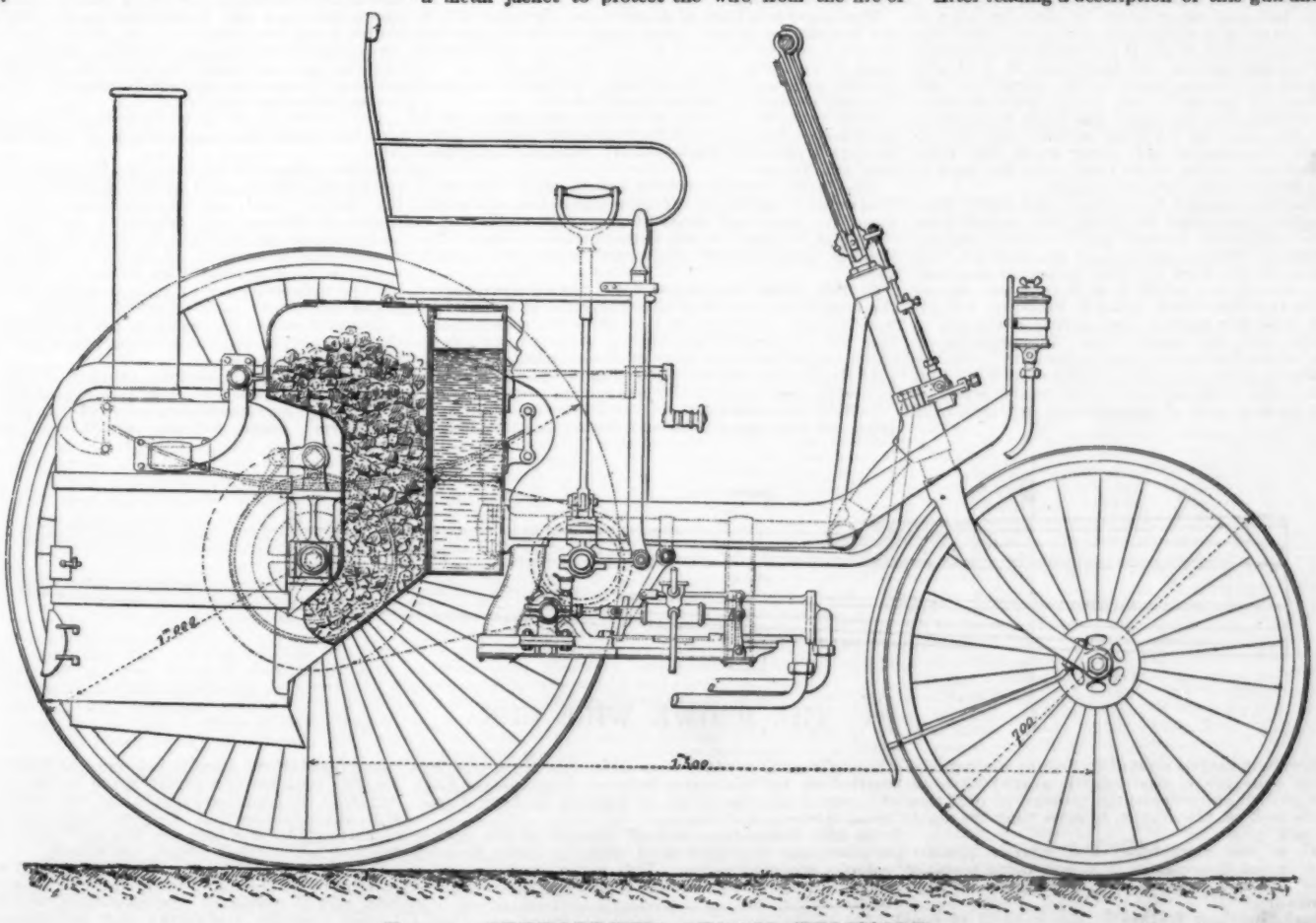


FIG. 1.—SERPOLLET'S STEAM TRICYCLE.

ing the plates, the question is often asked, How does the Brown gun differ from the Woodbridge gun with external staves?

Dr. Woodbridge describes his gun as follows: "A steel gun composed of an *inner steel tube, overlaid with longitudinal bars*, and then wound with steel wire under high tension, and finally soldered."

Omitting the question of soldering, you will notice that the inner core of this gun, *which sustains the winding*, is a solid steel tube overlaid with longitudinal bars; whereas, the inner core of the Brown gun, *which sustains the winding*, is a *segmental tube*, the lining tube not being inserted until after the winding is completed.

This is the essential difference between the Brown gun and all other wire guns. In the Brown gun the core which sustains the winding is a segmental tube; in all other wire guns it is a solid tube; in the Woodbridge, a solid tube overlaid with longitudinal bars.

Now, in a tube constructed upon the Brown principle, a much higher quality of metal can be obtained than it is possible to obtain in a solid tube. In the first place, the method of construction of the segments insures the greatest possible longitudinal strength, and a higher elastic limit for compression, than it is possible to obtain in a solid tube. Secondly, every segment can be carefully tested before using; whereas in a solid tube you must depend upon test specimens cut from the ends, to judge of the quality of the metal.

In all guns depending upon a condition of initial tension, the inner core is under a state of compression when at rest, produced by the outer hoops, and in wire guns by the tension of winding. The higher the physical qualities of the metal of the inner core, the higher the compressions that may be used. Consequently, the Brown segmental tube can be wound under a higher tension than it is possible to use in the case of a solid core. The present practice is not to compress any part of the core beyond its elastic limit; therefore, the Brown segmental tube can be compressed at its inner surface to a greater extent than a solid tube. Should it be found advisable to compress beyond this point, still the Brown tube will stand a higher degree of compression than it is possible to give to any solid tube for the same amount of distortion.

Now, the first action of the powder pressure is to overcome this compression; it will, therefore, take a higher powder pressure to overcome the initial compression at the inner surface of the core of the Brown gun than it will in any other gun. As soon as this compression is overcome, the powder pressure begins to stretch the core, exerting at the same time a compression in the opposite direction, and whenever any part of the gun is stretched beyond its elastic limit for extension, or compressed beyond its elastic limit for compression, a permanent set takes place in the metal.

In any wire gun the wire itself cannot be stretched beyond its elastic limit by gunpowder. Consequently, the only injury which can be done to a wire gun is to strain the core beyond its elastic limit. The segmental tube offers no resistance to circumferential stress, therefore, the only injury which can be done to a Brown gun by radical powder pressure is to compress the core beyond its elastic limit. It will, therefore, require a higher pressure to give a permanent set to the core of the Brown gun than to any other gun in the world. In fact, it can be shown mathematically that to give a permanent set to the core of a Brown gun is not within the possibilities of gunpowder, as ordinarily used.

A mere cursory observation will show that the greatest possible longitudinal strength obtainable from steel is obtained by the Brown system of construction. If this gun is not strong enough longitudinally, then it is impossible to build a gun from steel that will be.

There is but one other point to consider, viz.: *Is there any danger of derangement of the wire and segments during action?* While it is difficult to determine exactly when such action will take place, it is clearly evident that no derangement of the segments, and consequently of the wire, can begin until the compression between the segments has been reduced to zero at some point on its inner surface, and that no permanent derangement will occur until this compression throughout the entire tube over the area of maximum pressure has been so reduced.

The pressures required to produce this result have been carefully calculated for every ten inches from breech to muzzle by Birnie's and Crozier's formulas and tabulated. These calculations demonstrate that the pressure in the bore required to reduce this compression to zero at one point is 22·15 tons per square inch, while the maximum powder pressure will be but 18·24 tons per square inch, giving a margin of nearly four tons per square inch. The pressure required to reduce the compression to zero for the entire length of bore under maximum pressure is 37·87 tons per square inch. Consequently, there is absolutely no danger of derangement of the segments or wire during action.

The enormous muzzle strength of guns constructed upon this principle is particularly worthy of note. Thus the 10 inch gun will stand a pressure of 18·38 tons per square inch at the muzzle, or more than the maximum powder pressure.

In view of the characteristics of modern powder, this is of great importance; the gun being specially suited to powders giving a low maximum and high mean pressure.

Another important feature in the method of construction is that these guns may be constructed of great length at relatively much less extra cost per ton than is possible for a solid tube gun, it being no more difficult to roll a stave 60 feet long than one 30 feet long. An exceedingly high initial velocity with low pressure can be obtained by this system of gun construction, and it is entirely within the possibilities of the system to construct a 12-inch gun which will penetrate any armor extant.

Having thus shown that the ballistic qualities of the Brown wire gun are equal to, if not superior to, any other gun in existence, we will notice some other points.

The Brown gun can be constructed for less money and in less time than any other gun in the world.

No special plant of any great size is required. The tubes, segments, and wire can be obtained from two or three manufacturers in this country, and the gun can be assembled in any one of a dozen plants now in existence.

In conclusion, the advantages claimed for the system are as follows:

1. By the use of the small longitudinal segments a very much higher quality of steel may be obtained than is possible for a solid tubed gun.

2. This system of gun construction does not require a large special plant.
3. The rapidity with which these guns can be constructed.
4. Their relative cheapness.
5. Enormous elastic strength.
6. Commercial value of the metal after the gun has become unserviceable, due to the ease with which it can be dismantled.—*G. N. Whistler, Army and Navy Journal.*

THE NICARAGUA CANAL—ACROSS NICARAGUA WITH TRANSIT AND MACHETE.*

By R. E. PEARY.

THE action of this National Society, with its array of distinguished members, in turning its attention for an hour to a region which has interested the thinking world for more than three centuries gives me peculiar pleasure and satisfaction.

I propose this evening to touch lightly and briefly upon the natural features of Nicaragua, to note the reasons for the interest which has always centered upon her, to trace the growth of the great project with which her name is inseparably linked; to show you somewhat in detail, the life, work, and surroundings of an engineer within her borders; and, finally, to show you the result that is to crown the engineer's work in her wide-spreading forests and fertile valleys.

That portion of Central America now included within the boundaries of our sister republic Nicaragua has almost from the moment that European eyes looked upon it attracted and charmed the attention of explorers, geographers, great rulers, students, and men of sagacious and far-reaching intellect.

From Gomara the long list of famous names which have linked themselves with Nicaragua reaches down through Humboldt, Napoleon III., Ammen, Lull, Menocal, and Taylor.

The shores were first seen by Europeans in 1502, when Columbus in his fourth voyage rounded the cape which forms the northeast angle of the state, and called it "Gracias á Dios," which name it bears to-day. Columbus then coasted southward along the eastern shore.

In 1522, Avila penetrated from the Pacific coast of the country to the lakes and the cities of the Indian inhabitants. Previous to this the country was occupied by a numerous population of Aztecs, or nearly allied people, as the quantities of specimens of pottery, gold images, and other articles found upon the islands and along the shores of the lakes prove conclusively.

In 1529 the connection of the lakes with the Caribbean sea was discovered, and during the last half of the eighteenth century a considerable commerce was carried on by this route between Granada on Lake Nicaragua and the cities of Nombre de Dios, Cartagena, Havana, and Cadiz.

In 1821 Nicaragua threw off the rule of the mother country, and in 1823 formed with her sister Spanish colonies a confederation. This confederation was dissolved in 1838, and since then Nicaragua has conducted her own affairs. In point of advancement, financial solidity and stability of government she stands to-day nearly, if not quite, at the head of the Central American republics.

Nicaragua extends over a little more than four degrees each of latitude and longitude, from about N. 11° to N. 15° and from 83° 20′ W. to 87° 40′ W.

Its longest side is the northern border from the Gulf of Fonseca northeasterly to Cape Gracias á Dios, two hundred and ninety miles. From that cape south to the mouth of the Rio San Juan, the Caribbean coast line, is two hundred and fifty miles. Nearly due west across the Isthmus to Salinas Bay on the Pacific, is one hundred and twenty miles. The Pacific coast line extends thence northwest one hundred and sixty miles.

In point of size Nicaragua stands first among the Central American republics, having an area of 51,600 square miles. It is larger than either the State of New York or Pennsylvania, about the size of Denmark, Belgium, the Netherlands, and Switzerland combined, and is one-fourth as large as France or Germany. Its population numbers about 300,000.

The Gulf of Fonseca at the northern and Salinas Bay at the southern extremity of the coast line are two of the finest and largest harbors on the Pacific coast of Central America. About midway between them is the fine harbor of Corinto, and there are also several other ports along the coast, at San Juan del Sur, Brito, and Tamarindito. On the Caribbean coast no harbors suitable for large vessels exist, but numerous lagoons and bights afford the best of shelter for coasting vessels.

The central portion of Nicaragua is traversed, from north to south, by the main *cordillera* of the isthmus, which, here greatly reduced in altitude, consists merely of a confused mass of peaks and ridges with an average elevation scarcely exceeding 1,000 feet.

Between this mountainous region and the Caribbean shore stretches a low level country, covered with a dense forest, rich in rubber, cedar, mahogany, and dye woods. It is drained by several large rivers whose fertile intervales will yield almost incredible harvests of plantains, bananas, oranges, limes, and other tropical fruits.

West of the mountain zone is a broad valley, about one hundred and twenty-five feet above the level of the sea, extending from the Gulf of Fonseca southeasterly to the frontier of Costa Rica. The greater portion of this valley is occupied by two lakes, Managua and Nicaragua. The latter, one hundred and ten miles long by fifty or sixty miles wide, is really an inland sea, being one-half as large as Lake Ontario and twice as large as Long Island Sound. These lakes, with the rainfall of the adjacent valleys, drain through the noble San Juan River, which discharges into the Caribbean at Greytown, at the southeast angle of the country.

Between the Pacific and these lakes is a narrow strip of land, from twelve to thirty miles in width, stretching from the magnificent plain of Leon with its cathedral city, in the north, to the rolling indigo fields and the cacao plantations which surround the garden city of Rivas, in the south.

The lowest pass across the backbone of the New World, from Behring's Strait to the Straits of Magellan, extends along the San Juan valley and across the Lajas—Rio Grande "divide," between Lake Nicaragua and the Pacific; the summit of this divide is only one hundred and fifty-two feet above the sea and forty-two feet above the lake.

Nicarauga presents yet another unique physical feature. Lying between the elevated mountain masses of Costa Rica on the south and Honduras on the north, the average elevation of its own mountain backbone hardly one thousand feet, it is the natural thoroughfare of the beneficent northeast trades. These winds sweep in from the Caribbean across the Atlantic slopes, break the surface of the lakes into sparkling waves, and then disappear over the Pacific, aerating, cooling, and purifying the country, destroying the germs of disease and making Nicaragua the healthiest region in Central America.

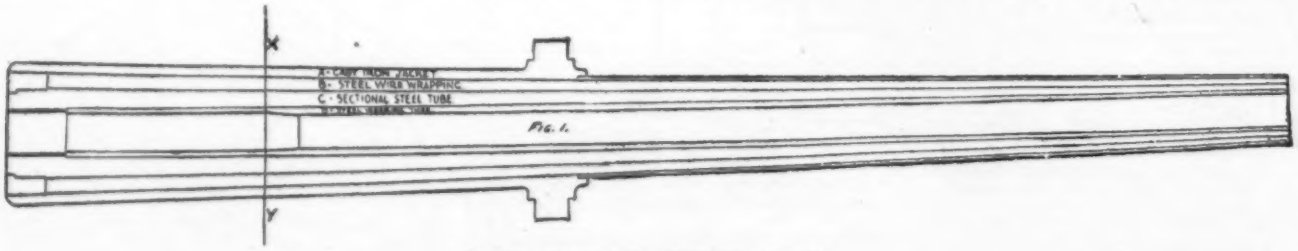
The scenery of the eastern portion of the country is of the luxuriant sameness peculiar to all tropical countries.

In the vicinity of the lakes and between them and the Pacific, the isolated mountain peaks which bound the plain of Leon on the northeast; the mountain islands of Madera and Ometepe; the towering turquoise masses of the Costa Rican volcanoes; and the distant blue mountains of Segovia and Matagalpa, visible beyond the sparkling waters of the lakes, feast the eye with scenic beauties, unsurpassed elsewhere in grandeur, variety, and richness of coloring.

The products of the country are numerous, despite the fact that its resources are as yet almost entirely undeveloped.

Maize, plantains, bananas, oranges, limes, and indeed every tropical fruit, thrive in abundance. Coffee is grown in large quantities in the hilly region in the northwest; sugar, tobacco, cotton, rice, indigo, and cacao plantations abound between the lakes and the Pacific; potatoes and wheat thrive in the uplands of Segovia; the Chontales region east of Lake Nicaragua, a great grazing section, supports thousands of head of cattle; and back of this are the gold and silver districts of La Libertad, Javali, and others.

Numerous trees and plants of medicinal and commercial value are found in the forests. Game is plentiful and of numerous varieties—deer, wild hog, wild turkey, manatee, and tapir; and fish abound in the streams and rivers. The temperature of Nicaragua is



THE BROWN WIRE GUN.

* An address delivered before the National Geographic Society, Washington. From the National Geographic Magazine.

equable. The extreme variation, recorded by Childs, was 23°, observed near the head of the San Juan in May, 1851.

The southeast wind predominates during the rainy season. Occasionally, in June or October as a rule, the wind hauls around to southwest and a *temporal* results, heavy rain sometimes falling for a week or ten days.

The equatorial cloud belt, following the sun north in the spring, is late reaching Nicaragua, and the wet season is shorter than in regions farther south. The average rainfall, based on the records of nine years, is 64·42 inches. The "trades" blow almost throughout the year. Strong during the dry season and freshening during the day; the wind comes from the east-northeast, and blows usually for four to five days, when, hauling to the east or southeast for a day or two, it calms down, then goes back to northeast and rises again.

The Spanish discoverers of the great Lake Nicaragua, coming upon it from the Pacific, and noting the fluctuations of level caused by the action of the wind upon its broad surface, mistook these fluctuations for tides, and felt assured that some broad strait connected it with the North Sea. Later, when Machuca had discovered the grand river outlet of the lake, and the restless searching of other explorers in every bay and inlet along both sides of the American isthmus had extinguished forever the *ignis fatuus* "Secret of the Strait," Gomara pointed this out as one of the most favorable localities for an artificial communication between the North and South Seas.

It was not until 1851, however, that an accurate and scientific survey of a ship canal route was made by Col. O. W. Childs.

This survey, which showed the lake of Nicaragua to be only one hundred and seven feet above the sea, and the maximum elevation between the lake and the Pacific to be only forty-one feet, exhibited the advantages of this route so clearly and in such an unanswerable manner that it has never since been possible to ignore it.

In 1870, under the administration of General Grant and largely through the unceasing efforts of Admiral Ammen, the United States began a series of systematic surveys of all the routes across the American isthmus from Tehuantepec to the head waters of the Rio Atrato; and six years later, with the plans and results of all these surveys before it, a commission composed of General Humphreys, chief of engineers U. S. army; Hon. Carlile Patterson, superintendent U. S. coast survey; and Rear-Admiral Daniel Ammen, chief of bureau of navigation U. S. navy, gave its verdict in favor of the Nicaragua route.

The international canal congress at Paris, in 1879, had such convincing information placed before it that it was forced, in spite of its prejudices, to admit that in the advantages it offered for the construction of a lock canal, the Nicaragua route was superior to any other across the American isthmus.

In 1876, and again in 1880, Civil Engineer A. G. Menocal, U. S. N., the chief engineer of previous governmental surveys, resurveyed and revised portions of the route, and in 1885 the same engineer, assisted by myself, surveyed an entirely new line on the Caribbean side, from Greytown to the San Juan River, near the mouth of the San Carlos.

On the eastern side of Nicaragua, all these surveys (except the last) were confined almost entirely to the San Juan River and its immediate banks, and the country on either side beyond these narrow limits was, up to 1885, almost entirely unknown. Between Lake Nicaragua and the Pacific, however, every pass from the Bay of Salinas to the Gulf of Fonseca had been examined.

In 1885 the party of which I was a member pushed a nearly direct line across the country from a point on the San Juan, about three miles below the mouth of the Rio San Carlos, to Greytown, a distance of thirty-one miles by our line, as compared with fifty-six miles by the river and forty-two miles by the former proposed canal route.

In December, 1887, I went out in charge of a final surveying expedition, consisting of some forty engineers and assistants and one hundred and fifty laborers, to resurvey and stake out the line of the canal preparatory to the work of construction.

The information and personal experience gained in previous surveys made it possible, without loss of time, to locate the various sections of the expedition in the most advantageous manner, and push the work with the greatest speed consistent with accuracy.

The location lines of the previous surveys were taken as a preliminary line and carefully remeasured and releveled. Preliminary offsets were run, the location made and staked off upon the ground, offsets run in from three hundred to one hundred feet apart, extending beyond the slope limits of the canal, borings made at frequent intervals, and all streams gauged.

The result of this work was a series of detail charts and profiles, based upon rigidly checked instrumental data, and covering the entire line from Greytown to Brito, from which to estimate quantities and cost.

As may be imagined by those familiar with tropical countries, the prosecution of a survey in these regions is an arduous and difficult work, and one demanding special qualifications in the engineer. His days are filled with a succession of surprises, usually disagreeable, and constant happenings of the unexpected. Probably in no other country will the traveler, explorer, or engineer find such an endless variety of obstacles to his progress.

Every topographical feature of the country is shrouded and hidden under a tropical growth of huge trees and tangled underbrush, so dense that it is impossible for even a strong, active man, burdened with nothing but a rifle, to force himself through it without a short, heavy sword or *machete*, with which to cut his way.

Under these circumstances the most observant engineer and expert woodsman may pass within one hundred feet of the base of a considerable hill and not have a suspicion of its existence, or he may be entirely unaware of the proximity of a stream until he is on the point of stepping over the edge of its precipitous banks.

The topography of the country has to be laboriously felt out, much as a blind man familiarizes himself with his surroundings. In doing this work the indispensable instrument, without which the transit, the level, and, indeed, the engineer himself, is of no use, is the national weapon of Nicaragua, the *machete*, a short, heavy sword.

As soon as he is able to walk, the son of the Nicaraguan *mozo* or *hulero* takes as a plaything a piece of iron hoop or an old knife, and imitates his father with his *machete*. As he gets older, a broken or worn-down weapon is given him, and when he is able to handle it, a full size *machete* is intrusted to him and he then considers himself a man. From that day on, waking or sleeping, our Nicaraguan's *machete* is always at his side. With it he cuts his way through the woods, with it he builds his camp and his bed, with it he kills his game and fish, with it at a pinch he shaves himself, or extracts the thorns from his feet, with it he fights his duels, and with it, when he dies, his comrades dig his grave.

When in the field the chief of a party, equipped with a pocket compass and an aneroid barometer, is always skirmishing ahead of the line with a *machetero*, or axman, to cut a path for him. A pushing chief, however, speedily dispenses with the *machetero* and slashes a way for himself much more rapidly.

As soon as he decides where the line is to go, the engineer calls to the *macheteros*, and the two best ones immediately begin cutting toward the sound of his voice. They soon slash a narrow path to him, drive a stake where he was standing, and then turn back toward the other *macheteros*, who have been following them, cutting a wider path and clearing away all trees, vines, and branches, so that the transit man can see the flag at the stake. The moment the leading *macheteros* reach him the chief starts off again, and by the time the main body of axmen have reached his former position the head *macheteros* are cutting toward the sound of his voice in a new position.

As soon as the line is cleared the transit man takes his sight and moves ahead to the stake, the chainmen follow and drive stakes at every hundred feet, and the leveler follows, putting in elevations and cross sections. In this way the work goes on from early morning until nearly dark, stopping about an hour for lunch.

After the day's work comes the dinner, the table graced with wild hog, or turkey, or venison, or all.

EMILE MULLER.

After dinner the smoke, then the day's notes are worked up and duplicated, and all hands get into their nets. For a moment the countless nocturnal noises of the great forest, enlivened perhaps by the scream of a tiger, or the deep, muffled roar of a puma, fall upon drowsy ears, then follows the sleep that always accompanies hard work and good health, till the bull-voiced howling monkeys set the forest echoing with their announcement of the breaking dawn.

In reconnoissance and preliminary work the experienced engineer is able, in many cases, to avoid obstacles without vitiating the results of his work, but in the final location, in staking out absolute curves and driving tangents thousands of feet long across country, no dodging is possible.

On the hills and elevated ground the engineer can, comparatively speaking, get along quite comfortably, his principal annoyances being the uneven character of the ground, which compels him to set his instrument very frequently, and the necessity of felling some gigantic tree every now and then.

In the valleys and lowlands there is an unceasing round of obstacles. The line may run for some distance over level ground covered with a comparatively open growth, then, without warning, it encounters the wreck of a fallen tree, and hours are consumed hewing a passage through the mass of broken limbs and shattered trunk, all matted and bound together with vines and shrubbery. A little farther on a stream is crossed, and the line may cross and recross four or five times in the next thousand feet. The engineer must either climb down the steep banks, for the streams burrow deep in the stiff clay of these valleys, ford the stream and climb the opposite bank, or he must fell a tree from bank to bank and cross on its slippery trunk twenty or twenty-five feet above the water.

Either on the immediate bank or in its vicinity is almost certain to be encountered a "*saccate*" clearing. This may be only one or two hundred feet across, or it may be a half mile. In the former case the "*saccate*" grass will be ten or fifteen feet in height and so matted and interwoven with vines and briars that a tunnel may be cut through it as through a hedge. If the clearing be large, the tough, wiry grass is no higher than a man's head, and a path has to be mowed through it, while the sun beats down into the furnace-like inclosure till the blade of the *machete* becomes almost too hot to touch.

But worse than anything thus far mentioned are the *Silico* or black palm swamps. Some of these in the larger valleys and near the coast are miles in extent.

Occupied exclusively by the low, thick *Silico* palms, these swamps are in the wet season absolutely impassable except for monkeys and alligators, and even at the end of the dry season the engineer enters upon one with sinking heart as well as feet, and emerges from it tired and used up in every portion of his anatomy. It is with the utmost difficulty that he finds a practicable place to locate his instrument, generally utilizing the little hummocks formed by the trunks of the clusters of palms, and in moving from point to point he is compelled to wade from knee to shoulder deep in the black mud and water.

General reconnoissances from high trees in elevated localities, simple enough in theory, are by no means easy in a country so miserly with its secrets as this, nor are their results reliable without a great expenditure of time, labor, and patience.

On level, undulating and moderately broken ground, the tops of the trees, though they may be one hundred and fifty feet from the ground, are level as the top of a hedge. Even an isolated hill, if it be rounded in shape, presents hardly better facilities; the trees at the base and on the sides, in their effort to reach the sunlight, grow taller than those on the summit, and there is no tree that commands all the others.

If, however, an isolated hill of several hundred feet in height be found, its steep sides culminating in a sharp peak, one day's work by three or four good axmen, in cutting neighboring trees, will prepare the way for a study of the general relief and topography of the adjacent country. If after these preliminaries have been completed the engineer imagines that he has only to climb the tree and sketch what he sees, to obtain reliable knowledge of the country, he is doomed to serious surprises in the future. If he makes the ascent during the middle of the day, he will, after he has cooled off and rested from his exhausting efforts, see spread out before him a shimmering landscape in which the uniform green carpet and the vertical sun combined have obliterated all outlines except the more prominent irregularities of the terrene, and have blended different mountain ranges, one of which may be several miles beyond the other, into one, of which only the sky profile is distinct. Naturally under these conditions estimates of distance may be half or double the truth.

There are two ways of extracting reliable information from these tree top reconnoissances. If it be in the rainy season, the observer must be prepared to make a day of it, and when he ascends the tree in the morning he takes with him a long, light line with which to pull up his coffee and lunch.

Then aided by the successive showers which sweep across the landscape, leaving fragments of mists in the ravines, and hanging gray screens between the different ranges and mountains, bringing out the relief first of this and then of that section, an accurate sketch may gradually be made. The time of passage of a shower from one peak to another, or to the observer, may also be utilized as a by no means to be despised check upon distance estimates.

If it be the dry season, the observer may take his choice between remaining on his perch in the tree from before sunrise to after sunset, or making two ascents, one early in the morning and the other late in the afternoon. In this case the slowly dispersing clouds of morning, and the gradually gathering mists at sunset, together with the reversed lights and shadows at dawn and sunset, bring out very clearly the relief of the terrene, the overlapping of distant ranges, and the course of the larger streams.

This kind of work cannot be delegated to any one, and besides the arduous labor involved in climbing the huge trees, there are other serious annoyances connected with it. The climber is almost certain to disturb some venomous insect, which revenges itself by a savage sting which has to be endured; or he may rend clothes and skin also on some thorny vine, or another, crushed by his efforts, may exude a juice which will leave him tattooed for days; then, though there may not be a mosquito or a fly at the base of the tree, the top will be infested with myriads of minute black flies, which cover hands and face, and with extremely annoying results. On the other hand, the explorer may as a compensation have his nostrils filled with the perfume of some brilliant orchid on some neighboring branch; and there is a breezy enjoyment in watching the showers as they rush across the green carpet, and in listening to the roar with which the big drops beat upon the tree tops.

(To be continued.)

EMILE MULLER.

EMILE MULLER, the eminent French engineer and architect, died at Nice on the 11th of November. Muller was born at Altkirch, in the Haut-Rhin, September 21, 1823. He belonged to a well-to-do family whose heads had won distinction in the army and the magistracy of Alsace. His father was a respected lawyer, who, as such, enjoyed a great reputation. He was obliged to leave Altkirch when the tribunal of that city was transferred to Mulhouse, a place already celebrated as an art and manufacturing center. The tastes of young Muller here took a decisive direction, and he immediately devoted himself to the first studies of industrial art. He soon became a pupil of the Central School, whence he was graduated in 1844 as an engineer, and with the record of an excellent pupil. At the advice of an old and illustrious comrade, Camille Polonceau, he began his career by leading the life of a workman. He entered the shops of the Railway Company of the East and became a machinist. It was doubtless there, among the shops that he desired to become thoroughly acquainted with, that his humanitarian feelings in favor of the laboring classes were developed. It was there, too, that he became possessed of those liberal ideas which, later on, caused him to search everywhere for personal merit and to take pleasure in finding it particularly among workingmen.

During his entire life, he loved to converse with the latter, and especially to grasp whatever of ingenious penetration that there was in them. His incessant efforts to secure the well being of his laborers had made a large family of them around him, which adored and venerated him as a father.

On leaving the railway shops, Muller soon followed his natural inclinations and began to occupy himself with work in architecture and building. As far back as 1845, we find him at Mulhouse, constructing school

houses, churches, baths, and lavatories and exploiting quarries and lime kilns. He soon entered upon a most interesting study, one of those that best agreed with his technical aptitudes and the aspirations of his mind, and that was his project for workingmen's dwellings. The success of his idea was so complete that he was at once charged with the construction of the workingmen's village of Mulhouse.

This new and important creation was followed by many other analogous ones, of which Muller was always the originator and in all cases the advising architect. In 1855, he gave a summary of his doctrines in a special work which is still authoritative. At about this epoch, associating himself with Mr. Bouillon, he founded at Paris a large establishment designed for the organization of bleaching works, baths, lavatories, and, in general, all that could interest public hygiene. The bases of this foundation were so solid and the inspiration that guided it was so complete that the establishment has not ceased to prosper up to the present.

We cannot undertake to enumerate all of Muller's works of construction and all his creations. Yet we cannot pass in silence the origin of the vast Ivry works, whose renown is now universal. It was in 1854 that, with the aid of his Mulhouse friends, Muller laid the first foundations of these ceramic works, which are now an object of national pride.

The history of the French exposition will tell of all the marvels contained in it, and on every page, where it is a question of its organization or of the beauty and the elegance of its structures, even in their details, the name of Muller will appear.

Muller rendered immense services to the Central School, to the chair of construction of which he was unanimously called in 1864.

When the idea of the cremation of the human body was first publicly discussed, Muller encouraged and lent it the aid of his experience. Faithful to his principles, he requested that his body should be cremated, and his desires were accordingly carried out.

After the incineration, on the 18th of November, the ashes were placed in an urn and deposited in the vault of the crematory to await a transfer to the family vault.

T. A. WALKER.

OUR readers will learn with much surprise and regret of the death of Mr. T. A. Walker, the well-known contractor of the Manchester ship canal and other great works. Some months ago it was found that Mr. Walker was suffering from Bright's disease, but it was only on Wednesday, November 20, that very serious symptoms showed themselves, when he was seized with paralysis. A turn for the better took place on Friday, but a relapse occurred on Sunday, and he died on Monday morning, November 25, 1889. He was 61 years of age, and leaves a widow and four daughters.

Some time ago, when reviewing Mr. Walker's book on the Severn Tunnel, we gave an outline of his career, and from that it would be seen that Mr. Walker was no ordinary man, but a born leader of men and a prince among contractors, as both in this country and abroad he was connected with some of the most important works of the age. Like most men of his type, he owed little to a regular course of education at school or college, but much to his own shrewd common sense and to the rough-and-ready school of practical experience. After a very short course of instruction at King's College, London, he found himself compelled to undertake railway work, in the year of the railway mania (1845), before he had reached the age of seventeen. During that and the following year he undertook considerable work on parliamentary surveys. In 1847 he obtained from Mr. Brassey a position on the North Staffordshire Railway, and he remained on Mr. Brassey's staff for seven years, the last two being spent on his great contract for the Grand Trunk Railway of Canada. For another seven years he remained in Canada, constructing railways in the lower provinces, and obtaining valuable experience in a large variety of work, and he returned in 1861, after an absence of nine years from home. His next important engagements were in Russia, and railway surveys in that country occupied much of his time in 1863. During the next two years he was engaged in Egypt and the Soudan in making surveys and explorations. In 1865, on his return to England, the management of the construction of the Metropolitan and Metropolitan District Railways was placed at the disposal of the three firms who had conjointly undertaken the contracts—Messrs. Waring Brothers, Peto & Betts, and John Kelk. He was connected with the undertaking until the completion of the contract in 1871, and its success was much due to the ingenuity of Mr. Walker in overcoming the many very serious difficulties which arose during the work. Shortly after this, in partnership with his brother, the late Mr. Charles Walker, he undertook the contract for the extension of the East London Railway from the end of Brunel's Thames Tunnel, under the London Docks, through Wapping, Shadwell, and Whitechapel, all of which was carried out to the satisfaction of the engineer-in-chief, Sir John Hawkshaw. His connection with Sir John led him to be intrusted with the still more difficult work of constructing the Severn Tunnel, which is fully described in the volume to which we have alluded. On the completion of that important undertaking a great pressure of work came upon him, such as the Barry Dock and Railways, the Preston Docks, the government docks at Buenos Ayres, and, most important of all, the Manchester Ship Canal. The energy and ability with which that work is being carried out proves that Mr. Walker was the right man for it, and that every expectation which had been held out was being abundantly fulfilled by the contractor. Fortunately, when Mr. Walker's illness began to take a serious form, legal arrangements were made which will allow the great undertaking to be carried out without interruption, and under the terms of his contract with the company. The directors were aware of the serious state of Mr. Walker's health, but feared that a report of his illness might injure the value of the shares, and for that reason the matter was not publicly referred to.

Like all really able men, Mr. Walker was very free from ostentation, and modest in his demeanor. He took great interest in the welfare of the men in his employment, and did a great deal for their physical, intellectual, and moral improvement, and his loss will be regretted as much by them as by the engineers and financiers with whom he came into contact in the course of his important engagements.—*Industries.*

LIME SULPHITE FIBER MANUFACTURE IN THE UNITED STATES.

By Major O. E. MICHAELIS, M. Am. Soc. C.E.

A BRIEF account of a comparatively new industry in this country, an industry which in the near future may demand the time, attention, application, and talent of hundreds of young American engineers, can hardly fail to possess some interest for the profession, and this consideration must be my apology for presenting a seemingly unscientific paper. It belongs exclusively to the domain of industrial engineering, yet I take it the scope of our society is broad enough to embrace everything that pertains to material progress and development, not only in the engineering science, but also in the arts of manufacture.

An engineer cannot be a school product. The ramifications of the profession, involving every application of scientific truth and mechanical invention to "the uses of man," have in this nineteenth century become too numerous to be even mentioned, far less studied, in any possible technical curriculum. There is only one practical school training for the modern engineer; his education should be so broad, so exact, that, when unexpectedly called upon to enter upon any given unanticipated investigation, construction, or manufacture, he can concentrate, crystallize, and absorb experience in a minimum space of time; and in our very best engineering schools, this truth controls, perhaps not avowedly, the course of study.

My object in broaching this view is to encourage our bright young graduates, to make them feel that even when foreign methods are in question, as in the manufacture concerning which I write, wherein virtually we are dependent upon cumbersome—I use the word advisedly—talent, a very little study, a very brief experience, will enable them to master the subject, and once mastered, "Improvements in the manufacture of sulphite fiber" will become a familiar caption in the *Patent Gazette*.

T. A WALKER.

Last fall, some acquaintances of mine, desiring to obtain information concerning the manufacture of wood cellulose by the bisulphite process, asked me to make an investigation. Accompanied by Mr. M. L. Griffin, M.A., of Holyoke, Mass., an expert wood pulp chemist, I visited Alpena and Detroit, Mich.; Appleton and Monico, Wis.; Cornwall, Ontario; Lawrence, Mass.; and Birmingham, Conn., at which places the various methods of making sulphite fiber were in actual operation.

Everywhere we were treated with courtsey and consideration, on occasion with generous candor and unreserved openness; indeed, it is not likely that two seekers for knowledge in this branch of manufacture will ever again have such exceptional facilities extended to them. Reports were made by Mr. Griffin and myself and the following is in the main the gist of what I reported; Mr. Griffin has kindly supplemented this by some remarks upon the chemical aspects of the subject. As I have in view only the desire to attract the attention of those who may soon make themselves competent experts to this opportunity for the remunerative application of their skill, I shall not enter into much detail, but merely give my own impressions as simply and as briefly as possible.

Sulphite fiber, or pure wood cellulose, supersedes rag stock in paper making. The wood in chips or disks is boiled in great digesters with a solution of bisulphite of lime, and the main engineering problem lies in the construction of a suitable, economical, and lasting digester. The processes examined, in alphabetical order, where the Graham, the Mitscherlich, the Partington, the Ritter-Kellner, and the Schenk.

The investigator is at once struck by the astonishing difference in size and boiling pressure between the Mitscherlich and all the other digesters; the former is 14×40 feet, the largest of the latter 10×28 feet; the steam gauge on the former registers 40 to 45 pounds, while on all others, 75 to 80 pounds. Why these differences? The reply to both these questions develops an intrinsic difference of operation between the Mitscherlich and all the other systems. The boiling point of liquids rises with the pressure, and while in all these sulphite processes we have to do with a solution of greater specific gravity than water, for purposes of comparison we can consider the temperature of the boiling point of water. According to Rankine, under a pressure of 40 to 45 pounds water boils at 267 to 275 degrees Fahr.; at 75 to 80 pounds, at 308 to 312 degrees. Hence Mitscherlich boils at about 40 degrees Fahr. lower temperature than the others, consuming, of course, more time for complete conversion, and to compensate, he boils a greater quantity.

Professor Mitscherlich claims that the slower boiling yields a better and surer output. His digester turns out from ten to fourteen tons, the others from one and a half to three tons, at a "boil." He requires for cooking from forty-five to seventy-two hours; the others, from fifteen to twenty-four.

Exteriorly all the digesters are of metal, all of open hearth steel or iron plate, except the Schenk, which is of so-called deoxidized bronze. All are approximately cylindrical, except the Partington, which is spherical. The cylinders are upright in the Ritter-Kellner and Schenk processes; in the Mitscherlich and Graham they are horizontal. The digesters are fixed, with the exception of the Partington and Graham, which revolve, the Graham about its longer axis.

Upon careful exterior survey of the digesters, I was struck by the fact that both the Partington and Ritter-Kellner were tapped at numerous points, and the holes closed by screw plugs. I learned that the purpose of these vents was to locate leaks; indeed, at Monico these holes were not closed, and the sulphite solution exuded in perceptible quantity.

Considered merely as a vessel strong enough to stand a given pressure, the only available substance of which the digester can be made, looking from an economical standpoint, is iron or steel. The majority of the digesters are made of rolled iron plates; the Detroit, of open hearth steel. There is no reason why our gun iron, with a tensile strength approximating 40,000 pounds, should not be available for digesters. They could be turned out in sections ready for assembling; the advantages of such a substitution for the complicated rivet work shell are evident. At remote inland points the large digesters must be assembled *in situ*, and boiler makers must now be transported for the purpose. A properly handled wrench would suffice to set up the sectional cast iron construction.

A 14×40 foot cast iron digester has been designed, with a factor of safety of 6, which will cost less than the riveted apparatus, to say nothing of the facility with which it can be transported and the ease with which it can be assembled by unskilled labor.

We come now to the inside of the digester. Owing to the well known affinity of the bisulphite solution for iron, all digesters made of this metal must be lined with a resistent, fluid-tight material, as a protection against the solvent action of the "acid" mixture. The Schenk digester, a uni-metal construction of deoxidized bronze, is assumed to be sufficiently resistent to the solution without protecting lining. The Graham, Partington, and Ritter-Kellner digesters are all lead lined, the Mitscherlich, fire brick lined. I use the word "firebrick" for want of a better. The bricks used are of special form, and are made of a German refractory clay, which seems to me to be about the same as is used in the manufacture of the Nassau Seltzer jugs.

DIGESTER LININGS.

The vital point in these sulphite processes lies in the ability of the digester to resist the erosive action of the acid solution and its gaseous products. Lead has for centuries been used as a lining material in the manufacture of sulphuric acid, so that its application to the present sulphite fiber processes lay near at hand. It is used in the Graham, Partington, and Ritter-Kellner digesters.

LEAD LINING.

In speaking of the sulphite process, the Encyclopædia Britannica uses the following language:

"The pulp or fiber produced by all these processes is of excellent quality, and can be prepared at a cost greatly lower than the soda process. The strength of the fiber is maintained unimpaired even after bleaching, and white paper made solely from such fiber is in every respect superior to that manufactured solely from pulp prepared by boiling with caustic soda.

"Dr. Mitscherlich's process has been extensively adopted in Germany, and there seems little doubt that these processes will in time supplant the use of soda in the case of wood. The great objection to them all is that, as they all depend on the use of bisulphite, which, being an acid salt, cannot be worked in an iron boiler, the boiler must be lined with lead, and great difficulty has been encountered in keeping the lead lining of the boiler in repair."

The primary, indispensable condition in protecting iron sulphite boilers with lead is that the lining must be continuous—that is, liquid tight.

Now, lead has a linear coefficient of expansion much more than double that of iron; in these processes it is subject to a change of temperature of at least 240° Fahr. (300–60°), and the unavoidable resulting flow of the metal cannot be compensated for by permitting sections to expand and to contract freely upon each other, for that would require open joints, a violation of our primary condition. The lead lining must in some way be attached to the iron shell, for otherwise it would soon collapse, or go to pieces in some other way. Only three practical ways offer themselves for the attachment of the lead lining to the iron.

It may be bolted on at proper points; it may be, to borrow a plumber's phrase, "tacked on," at appropriate places, or it may be completely soldered on. The first two methods permit, as is evident, under variations of temperature, changes in the superficial area of the lining; the latter method forcibly resists this, and limits the flow of the lead during the life of the solder union to molecular expansion only.

PARTINGTON.

This boiler, it will be remembered, is spherical; the lead is applied in spherical lunes, clamped to the iron, and burned to each other. The theory is that it is an easy matter to replace an injured section, and thus to keep the lining intact at comparatively little cost. At Monico, the vents in the shell, already spoken of as "leak locators," were all open, and the descriptive aptness of the words would be appreciated by any eye witness, *in eruption*. Having had some experience in lead

burning, I noticed at Monico extensive preparations for conducting it, and, in answer to my inquiries on the subject, the genial and capable superintendent admitted that he had had great trouble with the lining.

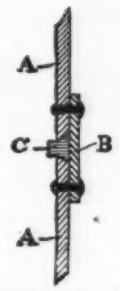
Indeed, the visible debris and the evident condition of the boilers were cogent evidence. It is needless to make further comment; "he who runs, may read" is here applicable. I learn that since my visit these boilers have been destroyed by fire, and have been replaced by another construction. At Lawrence, where a battery of eight Partingtons is in operation, the digesters were certainly more presentable; but there I observed that the usual hand apparatus for lead burning was apparently not considered sufficient, for the manager had applied an installation furnished with a power pump, and a system of conducting air and hydrogen pipes *in situ* at each boiler.

It is evident that in the Partington digester, the lunes must bulge from the iron under expansion, and must again be forced into contiguity under contraction and pressure. Hence, there is periodic "flapping," which, it seems to me, must in time result in fissuring. Of course, constant watchfulness and timely burning would prevent destructive results upon the shell. The expense of this can only be inferred from the statements made in regard to the cost of the output. Neither at Monico, nor at Lawrence, was an opportunity offered to make an interior examination. At Monico, such examination would have been merely a work of supererogation.

THE RITTER-KELLNER.

The digester, about 10 × 28 feet, is built up of cylindrical sections, 4 feet wide, a few inches apart, and fastened by heavy exterior bands. The object of this construction is to provide the means for attaching the lead lining peculiar to this process.

The spaces between these sections form annular dovetail mortises thus:



A. Boiler shell. B. Exterior band. C. Annular tenon of lead and antimony alloy.

These mortises are filled with an alloy of lead and antimony, and at the ends of a diameter meet similar vertical tenons, to which they are attached. The lining is burned fast to this semi-cylindrical frame. Here, again, under the irresistible force of expansion, these great sheets of lead, roughly speaking 16 × 4 feet, must theoretically, if the tacking holds, "pucker up," and again be forced back against the shell under contraction and pressure.

Again, it seems to me that this constant movement to and fro must, in the end, bring about fissuring. At Cornwall we were told no trouble of this kind has been experienced, and the digester we entered, more than half filled with chips, showed no evidence of degradation detectable in the very brief time at our disposal.

I asked two bright prominent officials, one of the parent, the other of the Canadian company, "What becomes of the increased superficial area due to the difference in the expansion of the iron and lead?" One said he didn't know and had no theory on the subject; the other replied: "This is no longer a matter of theory, it is an accomplished success."

The digester is, however, provided with abundant vents, or leak locators, and in reply to my question regarding their practical value, the gentleman in charge explained to me that by using a pneumatic pump the noisy issue of the air through the nearest vent located the leak. This was so graphically told, that I was at once convinced the description was founded upon auricular observation.

(To be continued.)

SUGAR MACHINERY AT THE PARIS EXHIBITION.

MACHINERY for the manufacture of sugar forms one of the specialties of the Cail Company. This branch of their industry is contemporary with the establishment of the works in 1812 by M. Ch. Derosne, who at that date had invented a system of purifying sugar by animal charcoal. Since then the company has been actively engaged in the manufacture of sugar machinery through all its stages of progress and development—the concentration of the juice *in vacuo* with double and triple effect apparatus, the purification of sugar by centrifugal action, its treatment *in vacuo* at low temperatures, the various processes of purifying juice, the different methods adopted for its saturation and carbonization, the diffusion process, the extraction of sugar from molasses, the manufacture of finished sugar in cubes: all these and many other systems have been worked out and put in practice by the Cail Company, who have always kept abreast of other manufacturers in this branch of industry.

The total production of sugar in France during last year was 420,000 tons; of this total more than one-third was made in one hundred factories, established by the Cail Company, while one hundred more have been modified and more or less transformed by them. Out of over one hundred sugar factories established by the company abroad, the largest are the thirteen great works erected in Egypt for the Khedive, and the Darboussier factory, which treats 1,000 tons of cane daily. Altogether, about 500,000 tons of sugar are produced annually in factories equipped by the Cail Company.

The Cail Company exhibited at the Paris exhibition under nine classes, all of them in group 6. These classes are as follows.

Class 48. Material and processes for working mines and metals. There was only one exhibit in this class, the drawings of a winding plant similar to those recently constructed at the Denain Works for the coal mining company at Anzin. The capacity of this plant is to lift five tons at each operation, of which two tons are paying load; the speed of lift is 26 ft. per second. The amount of coal raised with this plant is 600 tons in twelve hours, from a depth of 1,968 ft. The engine employed has two cylinders 19·69 in. in diameter, and 7 ft. 2·6 in. stroke.

Class 50. Materials and processes employed in agricultural factories and food industries. The most important objects exhibited in the pavilion came under this class, and consisted chiefly of machinery for the production of sugar.

First may be mentioned a beet root cutting machine, which possesses some points of interest. The roots having been previously washed, are thrown into a hopper and fall upon a disk 5 ft. 1·5 in. in diameter, which carries on its surface twenty knives, each 13 in. long. The disk is driven at a speed of ninety revolutions per minute, and the proper distribution of the roots against the knives is secured by means of inclined guiding bars attached to the hopper.

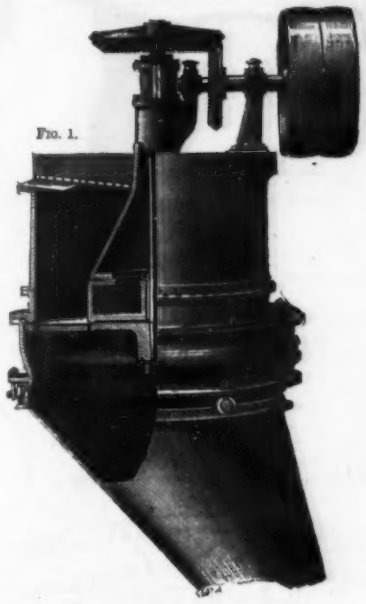


FIG. 1.

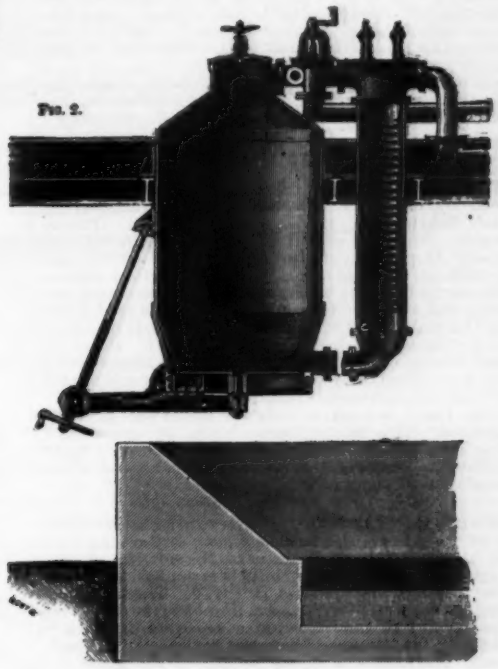


FIG. 2.

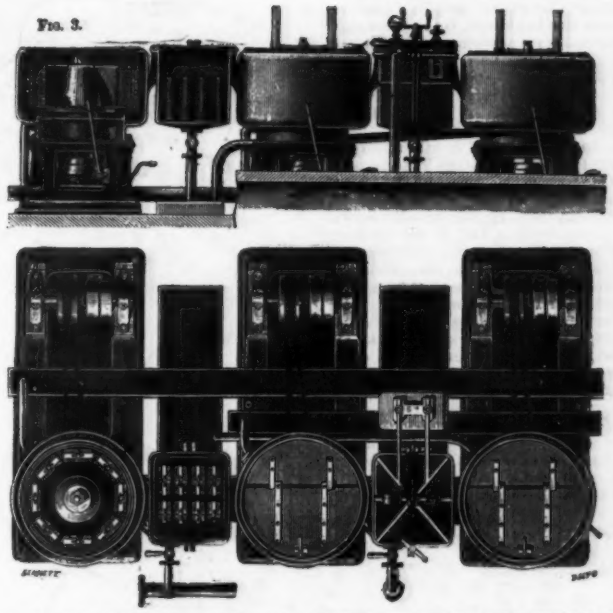


FIG. 3.

SUGAR MACHINERY AT THE PARIS EXHIBITION.

The illustration, Fig. 1, shows the general arrangement of this apparatus, and it will be seen that the shaft carrying the revolving disk is supported by a suitable frame in the center of the hopper, so that the latter is not obstructed by transverse supporting bars. By this arrangement the whole of the area underneath the disk is available for the roots after they are cut to fall down into the diffusing cylinders; the conical hopper, through which they pass, is mounted on rollers so that it can be turned round to feed a battery of diffusers if these latter are arranged in a circle. The machine exhibited can cut up 250 tons of roots in twenty-four hours.

There was exhibited a half-battery of diffusers manufactured by the works at Douai; it comprised six diffusing cylinders with the same number of heating drums, arranged for a straight line battery. The other six apparatus completing it would be placed symmetrically with the one shown, the beet root cutting machine in the middle, with suitable conductors leading the cut roots to each diffuser.

Fig. 2 shows the general arrangement of one of the cylinders forming the plant. The heater contains a coil through which either live or exhaust steam can be passed, the latter method being largely adopted. The system of closing the bottom of the diffuser is one of the specialties of this exhibit. The bottom is secured to the vessel by a bayonet joint, perfect tightness being secured by a rubber packing. The opening and closing of the vessel is effected by an inclined screw and hand wheel, the bottom turning on the center pin secured to the side of the vessel.

A diffusion apparatus was also shown for treating cane and bagasse. The peculiarity of this arrangement consists chiefly in the means adopted to discharge the contents of the vessel, a more difficult operation on account of the tendency which the pieces of cane possess of interlocking and becoming bound inside the diffuser. In the apparatus that was shown, the vessel had the form of a truncated cone, the larger diameter being at the bottom, which was closed by a door firmly secured by a modification of the bayonet joint already referred to. It was further held in place by a system of bolts operated from the working platform of the apparatus.

A very interesting exhibit was that of a group of turbines for the refining of sugar and its direct production into cubes or slabs ready for use. After the sirups obtained from the raw sugar have been sufficiently purified they are passed into heating vessels, and thence fall into the crystallizers, which form a part of this apparatus. These crystallizers consist each of a receiver made of galvanized iron plate divided into eight sections by means of movable partitions. These spaces are again divided into a certain number of small compartments by narrow zinc strips, and when the receivers are charged, these compartments become filled by the heated sirups from the boiler and ultimately become finished slabs of sugar. It is evident that the thickness of these slabs can be varied by the arrangement of the zinc strips. The receivers having been charged, the mass is allowed to crystallize, and the eight blocks contained in each receiver are removed. This is easily effected by reversing the receivers, which are slightly tapered, upon a table. The blocks are then attached to a light frame and placed within one of the refining turbines. The contents of each crystallizer are sufficient to charge a turbine. The remainder of the process consists of three successive operations in the apparatus, of which a general view is given in Fig. 3.

The first receiver having been charged, the blocks it contains are subjected to centrifugal action until there is no discharge through the tube at the bottom of the turbine. The blocks are then removed and placed in the cast iron recipient where the first clearing process takes place. The sirup employed for this purpose is

that coming from the operation in the third turbine. The blocks are afterward taken from the receiver and placed in the second turbine, where the process is repeated. Coming from there they are inclosed in a second cast iron receiver and again treated, this time with new sirup. A similar treatment in the third turbine completes the operation.

After the process is finished the blocks are taken out of the frames and the small strips of zinc dividing the mass into slabs are taken out. The sugar may then be placed in the finishing stove, and after some hours it is ready for use.

A number of these apparatus are in successful work. In one of them especially, that of MM. Mercier & Co., of Bresles, twenty tons of moulded sugar are made, and of this fifteen tons are fit for packing in boxes. The amount of broken sugar by this process is, therefore, only about twenty-five per cent.

Besides the exhibits, of which we have given a general idea, there was a considerable amount of other sugar machinery exhibited. Thus there are several types of filter presses, triple effect low temperature evaporators, in which only exhaust steam is employed, closed boilers for treating the sirup *in vacuo*, and concentrating it up to crystallization point, apparatus for extracting the sugar contained in molasses, and continuous distilling apparatus especially adapted for treating the products of molasses. This class of machinery has been a specialty of the Cail Company since it was founded, for in 1812 M. Derosne constructed his first distilling apparatus, and the manufacture has been continued by the firm ever since.—*Engineering.*

THE CURVE RANGER.

WE illustrate a most ingenious little instrument designed by Mr. A. P. Trotter, and manufactured by Elliott Brothers, St. Martin's Lane, London. The instrument, which is shown in perspective in Fig. 1, is intended to perform all the operations of curve ranging without, in most cases, requiring any calculation whatever to be made by the operator, as the chord, arc, versin, and many other quantities can be read direct from the scales with which the instrument is provided. The instrument is based on Euclid, III., Prop. 21, where it is proved that the angle in the segment of a circle is constant, and the instrument itself is a modification of the ordinary sextant.

At A, Fig. 1, is a mirror, only the upper half of which is silvered. This mirror moves with the upper scale, and is provided with a vertical cross line. The figure of the curved edge of the upper scale is a polar curve whose equation is

$$r = a + b \sin 2\theta,$$

where a is the distance from the zero graduation to the axis of the mirror, and b is the length of the scale from zero to 2, and θ the inclination of the mirror. At B is an eye piece. Suppose, then, it is intended to range a curve between the points A B, Fig. 6. Then A and B being given, the curve connecting the two is determined by any of the following seven quantities, all of which can be obtained from the scales of the instrument: The radius X B, the length of the arc A C D E B, the versin D K, the angle at the center A X B, the angle, F A B, between the chord and a tangent, the angle, A O B, between the tangents, or the tangential angle, O A B. If the radius is chosen, say 10 chains, then the ratio of chord to radius is $\frac{15}{10} = 1{\cdot}5$. Then the graduated edge of the curved limb is set to cut the center line engraved on the body of the instrument (marked ratio of chord to radius) at 1·5, and clamped in this position by a thumbscrew provided for the purpose, being finally adjusted exactly by a tangent screw in the usual way. Let any position, such as C, be taken up and the instrument held in the hand, then if the point, C, is on the curve, both A and B can be seen simultaneously through the eye piece of the instrument, one point by reflection and the other by direct vision. If the two stations cannot both be seen, the operator moves to the right or left until this is the case, and the staves at A and B are both superimposed on the cross line of the mirror. In this way any number of points in the curve can be fixed as the observer moves from A and B, and on arriving at this part the tangent is also obtained, and a ranging rod can be set up at any convenient distance to mark this. To find the length of the arc from A to B, it is only necessary to multiply the radius by a number engraved on the back of the instrument where the slanting edge of the body cuts a scale-marked arc. Fig. 4 shows all the elements of a curve that can be obtained either by direct reading from the scales of the instrument or by simple arithmetical calculation. These are:

Radius A O = 1		
Chord A B,	read direct on scale.	
Arc A F B,	" " " "	
Versin F H.	" " " "	
Angle A C B,	" " " "	left to right.
" E A B,	" " " "	" " "
" A O B,	" " " "	right to left.
" G A B = ½ A O B		
" A G B = 180 - A O B		
" O A B = E A B - 90		

$$\text{Distance G F} = \frac{\text{A H}^2}{\text{H O}} - \text{F H}$$

Again, in Fig. 5, to find the distance from the intersection of the tangents to the middle point of the curve, take the square of E B (half the chord E F), and divide it by A B (the radius minus the versed sine). This gives the distance C B, from which the versed sine may be subtracted to give the distance, C D, required. Or,

$$\frac{\text{B E}^2}{\text{B A}} - \text{B D} = \text{C D}.$$

Supposing it is required to set out a tangent to any given arc. Let A, Fig. 7, be this point. Then set up rods at C and B, any two other points in the curve, and take a position at C, and adjust the instrument till A and B are superimposed on the cross line. Then moving back to A, observe B by direct vision and set up a rod at D in the line of sight by reflection. Then D A is the tangent required.

Suppose that a line composed of arcs and straight lines is required, such as A B C D E, Fig. 8, and with the length shown range a tangent from A and measure 5 chains in the direction of B. Let B C = 8·6 chains, then set the instrument to ratio of arc to radius of $\frac{8{\cdot}6}{20} = 0{\cdot}43$, and with this range curve B C. Then at C set the instrument to ratio of $\frac{11{\cdot}20}{15} = 0{\cdot}743$, the numerator being length of arc C D, and range the curve C D, and from D the tangent can be obtained as previously described.

As another case, Fig. 9, suppose the angle between the tangents and the middle point of the curve given. Then subtract the angle from 180, and the difference = the angle at center of curve. Thus suppose the given angle is 56, then angle at center = 124 deg. Take half this = 62 deg., and set the instrument at this point of the graduated edge, using the upper row of figures. Then walk along the tangent till a rod, A, set up somewhere in the tangent is seen by reflection superimposed with the point B on the cross line of the mirror. The position of the instrument then marks the point, C, where the tangent meets the curve. Then proceeding with the instrument to B, set the limb at 124 deg. and sight C by reflection. Where the line of direct vision cuts the other tangent, is then the point of contact with the curve, which can then be ranged as previously described.

If three points of the curve are given, as in Fig. 10, and all are accessible, set up rods at A and C, and at B place both on the cross line, and then range the curve with the angle so obtained. If, however, as in Fig. 11, an obstacle intervenes between A and E, it will not be possible to set out in this way more of the curve than the arc B C D. When, however, the points B and D are obtained, the rest can be set out by taking a new angle at B, as *e. g.* the angle A B D, and completing the arc between A B with this.

As a final case, suppose no data whatever are given, as in the surveys for a colonial railway, where no previous surveys are in existence. Let Fig. 12 represent such a case, and suppose the surveyor has arrived at the point A, and there finds obstacles which render a deflection of the line necessary. All that is necessary for him to do in such a case is to select a number of points, B C D E F, which will carry his line clear of the obstacles, and then these curves can be filled in with the instrument and be either fully marked out or their tangent points alone fixed on the ground, in which case the radii and lengths of the arcs would be recorded after reference to the instrument. It should be observed that, though the instrument is not intended to replace the theodolite in very accurate surveying, it nevertheless has one very great advantage over the older instrument, in that errors made by it are not cumulative, and no assistants, chain, or tables are required, as is the case when curves are set out by the method of tangential angles with the theodolite.—*Engineering.*

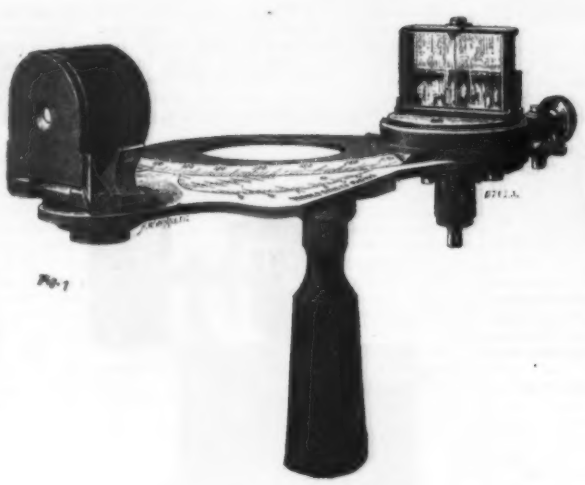


Fig. 1.

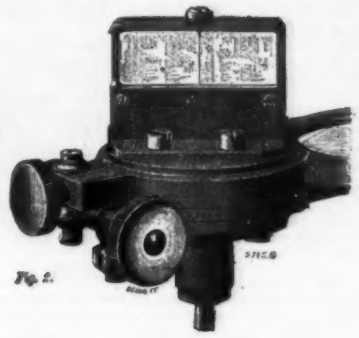


Fig. 2.

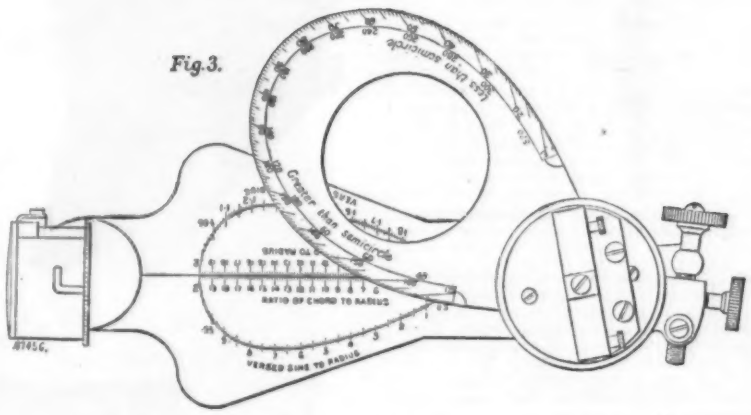


Fig. 3.

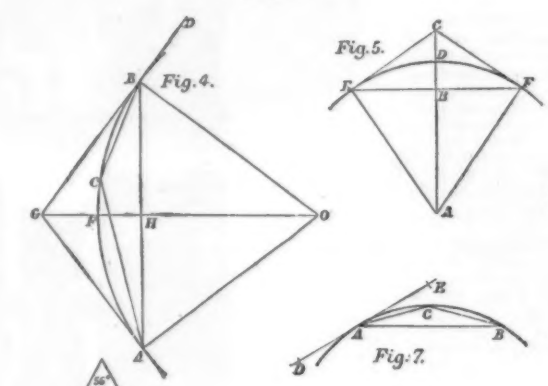


Fig. 4.

Fig. 5.

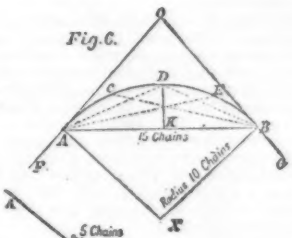


Fig. 6.

Fig. 7.

Fig. 8.

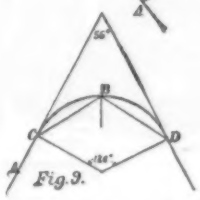


Fig. 9.

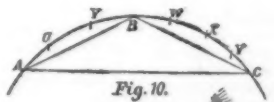


Fig. 10.

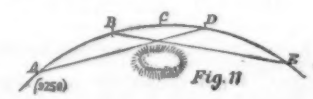


Fig. 11.

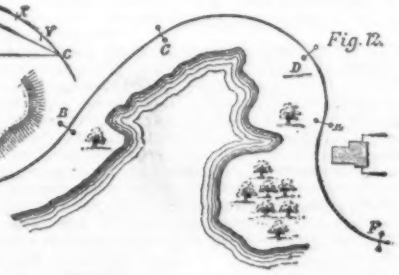


Fig. 12.

AN INEXPENSIVE INDEX PLATE.

MECHANICS generally, and amateur mechanics especially, often have occasion to divide a circle, as in gear cutting or fluting a reamer. To those possessing a gear cutter, or gear-cutting attachment to the lathe, it is very easy, but to one who has no conveniences for such work it is quite troublesome. It is not an easy matter to lay out and drill an index plate. It is comparatively easy to copy a plate, but the plate is not always accessible.

To enable the amateur to avail himself of the use of an index plate with little expense, the annexed photo-engraving has been prepared from a useful plate, and other engravings have been added, showing the application of the plate to a lathe. This print is designed to be cut from the paper and pasted on the metallic plate, B, and the plate is to be attached to the face plate, C, of the lathe, as shown in Figs. 2 and 3. It is important to center the plate with the paper impression accurately in the lathe. For this purpose a center mark and two circles have been provided. The metallic plate should project at least one-fourth inch beyond the paper disk, to receive the clamp by which the plate is held while the cutting is being done.

The following is a table of the divisions that may be made with this plate:

240, 200, 150, 144, 132, 124, 120, 112, 108, 104, 100, 92, 84, 80, 75, 72, 66, 63, 60, 56, 54, 52, 50, 48, 46, 44, 42, 40, 38, 36, 33, 31, 30, 28, 27, 26, 25, 24, 23, 22, 21, 20, 18, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2.

Below is a table of the divisions of each circle:

240	200	150	144	132	124
120× 2	100× 2	75× 2	72× 2	66× 2	62×2
80× 3	50× 4	50× 3	48× 3	44× 3	31×4
60× 4	40× 5	30× 5	36× 4	33× 4	
48× 5	25× 8	25× 6	24× 6	22× 6	
40× 6	20×10	15×10	18× 8	12×11	
30× 8			16× 9		
24×10			12×12		
20×12					

112	108	104	92	84	76
56×2	54×2	52×2	46×2	42×2	38×2
28×4	36×3	26×4	23×4	28×3	19×4
16×7	27×4	13×8		21×4	
14×8	18×6			14×6	
				12×7	

Referring to the engraving, A is the paper disk which is attached to the metal plate, B, by means of fine starch paste or a mucilage made from gum tragacanth. The plate, B, is secured to the face plate, C, of the lathe by three screws. After the plate is centered and fastened, the center is cut away to allow the blank-holding spindle, O, to enter the lathe mandrel in the place of the usual center.

A bar, D, which is preferably made of cast iron, but which may be made of wood, is secured to the lathe by a bolt passing downward through the lathe bed and through a crossbar underneath. The bar, D, is provided with a standard, E, which extends behind the plate, B, about one-fourth inch. To the front of the standard, E, is loosely attached a jaw, F, by means of dowel pins. This jaw extends over the face of the plate, B, about one-fourth inch, and is made to bear upon the plate, and thus clamp it to the standard by means of the thumbscrew.

On a screw, K, extending into a standard, I, projecting from the bar, D, is pivoted an arm, J, having an enlarged end, *a*, in which there is an aperture a little larger in diameter than one of the circular dots on the index plate. The arm, J, may be swung opposite any row of dots on the plate, B. The registering of the plate is accomplished by bringing the dot opposite the hole in the index, so that an annular space is seen around the dot through the hole in the index. The hole should be countersunk and the index should be

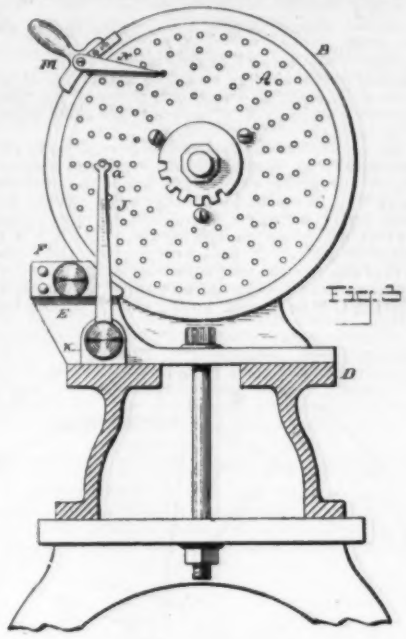


Fig. 3.

FIG. 3.—FRONT ELEVATION OF PLATE APPLIED TO THE LATHE.

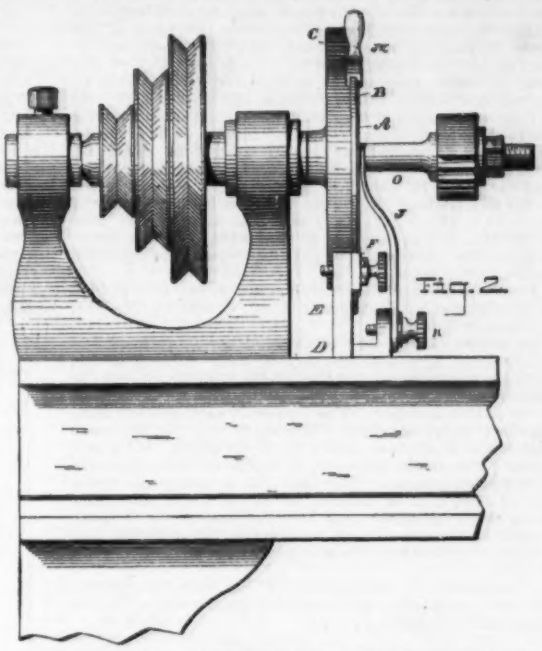


Fig. 2.

FIG. 2.—SIDE ELEVATION OF LATHE, SHOWING APPLICATION OF INDEX PLATE.

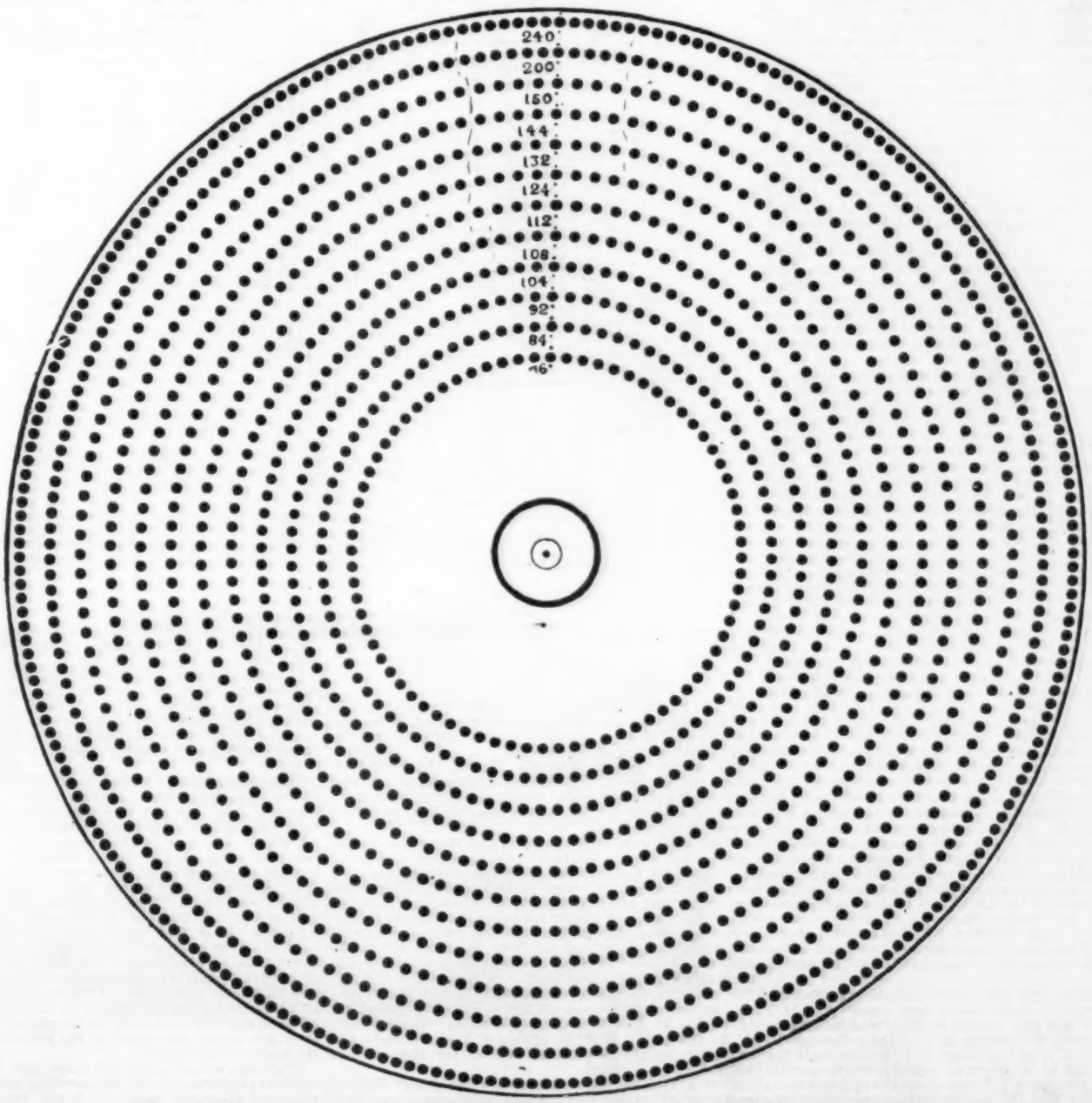


FIG. 1.—AN INEXPENSIVE INDEX PLATE.

allowed to touch the plate lightly. A magnifying glass assists greatly in securing a perfect registration. As most wheels will be cut with teeth numbering aliquot parts of the rows of dots, the chances of inaccuracies will be correspondingly decreased, but in such a case errors may arise in the counting of the dots for a new position of the plate. To guard against such errors, a clamp, M, is provided which embraces the edge of the plate, B, and carries a pointer, N, which is pivoted, so that it may be made to point to a dot in any of the rows of dots. Suppose it is required to cut a wheel, the teeth of which would require the use of only one in four of the dots of a given circle; then after moving the plate and clamping it fast by means of the screw, the clamp, M, would be moved back four dots, and after the wheel was cut the screw, G, would be loosened and the plate, B, would be moved until the dot pointed to by the pointer, N, would be seen in the center of the hole in the index, J. The metal around the hole at the side and upper part of the index, J, is cut away to allow the pointer, N, to pass downward opposite the center of the hole.

As to the method of cutting small gears in the foot lathe, the reader is referred to SUPPLEMENT, No. 317, "Amateur Mechanics."

Each row of dots may be divided up as follows, the heavy faced figures at the top of each column in the above table representing the whole number of dots in each row, while the figures below represent aliquot parts of this number. The figures in each column indicate how many spaces it is necessary to move the plate each time the wheel blank is to be shifted for a new cut to produce the number of teeth directly opposite in the other column. For example, in using the outer row of dots, if it is desired to cut 80 teeth, the plate must be moved three dots for every tooth, for 60 teeth four dots, and so on; or to reverse the order, to cut 3 teeth the plate must be moved 80 dots, and for 4 teeth 60 dots.

It is possible by the exercise of due care in registering and clamping to produce very good work with this inexpensive apparatus. G. M. H.

RADII OF CURVATURE GEOMETRICALLY DETERMINED.

By Prof. C. W. MACCORD, Sc.D.

XII.—THE HELIX.

THIS familiar curve is generated by the motion of a point which revolves at a uniform rate about an axis from which it remains at a constant distance, and also travels at a uniform rate in a direction parallel to the axis; the two rates being independent of each other. It therefore lies on the surface of a cylinder of revolution, as shown in Fig. 43, where V′ A′ W is the vertical projection of one half of a coil, lying on the front side of the vertical cylinder, and V A D is the horizontal projection. Z Z is the plane tangent to the cylinder along its nearest element; the tangent to the helix at A′ lies in this plane and is readily drawn by Roberval's method, thus: set off A′ B′ in a horizontal direction equal to the length of the quadrant A D of the cylinder's circumference, representing the velocity of the revolution; set off A′ E in a vertical direction, equal to one-fourth the pitch of the helix, representing the velocity of the motion parallel to the axis; then completing the parallelogram, the diagonal A′ F gives the resultant motion at the instant, and fixes the direction of the tangent T T.

It was shown in Art IX. of this series that if the normal to any plane curve is always parallel to any line whose angular motion is known, the center of curvature can be readily located when the motion of one point in the normal is given, and although the helix is not a plane curve, the same mode of operation that was adopted in the article referred to may be successfully used in this case as well.

Regarding A C as simply a radius of the cylinder, it will in revolving around the axis sweep out a circle in a horizontal plane. Compounding the vertical translation with this revolution, A C becomes the generatrix of a right helicoid, and being perpendicular to the tangent plane Z Z, is normal at A to the helix traced by its outer extremity. The center of curvature evidently lies at some point beyond the vertical axis, upon the normal, which, being not merely parallel to but coincident with the radius of the cylinder, must have the same angular motion.

If we suppose the velocity of A′ in the horizontal circle to be A′ G′, the helix will be generated at the rate A′ P. Now if we imagine the vertical translation momentarily to cease, the generatrix of the helicoid will travel on in the horizontal plane, and the velocity of its outer extremity will be determined by the consideration that A′, regarded as its outer extremity, is also a point in that normal to the helix which lies in the tangent plane Z Z; this velocity is therefore ascertained by drawing through P a perpendicular to T T, cutting the horizontal line through A′ in H′. In the horizontal projection both these velocities are seen in their true lengths as A G, A H; therefore A C G represents the angular velocity of the radius of the cylinder; and H O parallel to G C will cut A C produced in O the required center of curvature.

The same result may be reached in another way, as follows: The motion of A′ in its helical path may be regarded at the instant as a rotation in the plane T T (perpendicular to the vertical plane of projection) about an axis parallel to the vertical plane and passing through the center of curvature; this axis is represented by N N. As seen above, a velocity, A′ P, along the helix requires an angular motion of the radius of the cylinder represented by A C G in the horizontal projection, when A G is equal to A′ G′. Since A′ G′ has a component A′ I in the direction T T, this rotation of A C about the vertical axis has a component rotation in the plane, T T, about an axis passing through C, parallel to N N.

In a projection upon the plane, T T, the radius, A C, of the cylinder will be seen in its true length as A″ C″, and A′ I, A′ P will also be seen in their true lengths as A″ I″, A″ P″, perpendicular to A″ C″. Draw through P″ a parallel to I″ C″, and it will cut A″ C″ produced, in the point O″, giving A″ O″ as the radius of curvature.

Yet again, the plane T T cuts from the cylinder upon which the helix V′ A′ W lies, an ellipse, seen in its true size in the projection last made, when the major axis appears as K″ J″, and A″ C″ is the semi-minor axis. This ellipse is obviously an osculating curve to the helix at A′, and at that point will have the same radius of curvature. Since in the vertical projection A′ J and A′ L are respectively the semi-major and the semi-minor axes, this radius of curvature may be at once constructed by drawing through J a perpendicular to T T, giving $\frac{A\,L}{A\,J} = \frac{A\,J}{A\,M}$, whence $A\,M = \frac{A\,J^2}{A\,L}$, which is the required value. (See Art. VI. of this series.)

Comparison of the similar triangles made use of, at once proves this result identical with those of the preceding methods; and as A″ C″ and A C are each equal to A′ L, we have C O = C″ O″ = L M.

Since all points of the generating normal have the same component of vertical translation, the locus of the center of curvature, or in other words the evolute, of the helix V′ A′ W, must be another helix having the same pitch, but lying upon a smaller cylinder whose radius is C O, as shown in the figure, where X A′ Y is the vertical projection of that evolute, and the circle through O is the horizontal projection of the cylinder.

This cylinder cuts A C in Q; now draw Q R parallel to Z Z, cutting C B in R, and noting that N N cuts the horizontal line through V′, in the point R′, we shall have

$$\frac{S\,R'}{L\,M} = \frac{S\,A'}{J\,L} = \frac{F\,B'}{J\,L} = \frac{A'\,B'}{A'\,L} = \frac{A\,B}{A\,C} = \frac{Q\,R}{C\,Q};$$

but L M = C Q, therefore S R′ = Q R. But also, A B is by construction equal to the quadrant A D, consequently Q R is equal to the quadrant Q U of the circumference of the small cylinder.

We see then that N M, the axis of the osculating circle of the helix V′ A′ W, is tangent at A′ to the evolute; in the horizontal projection this axis appears as *n* O *n* parallel to Z Z, and in the third projection it is seen as the point O″.

Thus it appears that the helix and its evolute are so related that a plane normal to the former at any point is tangent to the latter at the corresponding center of curvature, and *vice versa*. Furthermore, they have the reciprocal relation that each is the evolute of the other, the radius of curvature being the same for both.

For, applying the third of the preceding methods to the helix X A′ Y at the point A′, we have A′ *l* as the semi-minor, and A′ *j* as the semi-major axis of the osculating ellipse. But in the triangles A′ *l j*, M *l j*, the homologous sides are parallel, and A′ *l*, M *j* are also equal; therefore, A′ *j* = M *j*, and the perpendicular to A′ *j* at *j*, will cut the horizontal line through A′, in the point M, thus giving A′ M as the radius of curvature for the evolute as well as for the original helix.

It is a familiar fact that if a rectangular sheet of metal or of paper, upon which a diagonal has been drawn, be rolled up into a cylinder, the diagonal will become a helix; and conversely, if a cylinder upon which a helix has been traced be developed into a plane, the helix will become a right line. So, if a helical spring be rolled upon a plane surface, each coil will measure itself off upon its tangent; in this case the action, owing to the presence of several coils, is virtually the rolling of the cylinder upon which the spring is wound.

But it seems not to be so generally known that this curve can be developed upon a plane in another way, an idea of which can be formed by supposing a single coil of the spring to be cut off and spun upon a table as a coin is by twirling it between the thumb and finger. The peculiar motion of the coin as it rolls upon its edge after losing its vertical position is familiar to every one, and a very similar action will take place in spinning the coil of wire.

Or, at least, it will begin to take place; the true rolling, as will presently appear, can continue through only a limited portion of the coil, but this is due to interference of the plane with a part that has already measured itself off, and not to any difficulty with the part beyond. The rolling contact is perfect as it progresses, and the comparison to the "wabbling" of the coin may aid in showing that "the twist can be taken

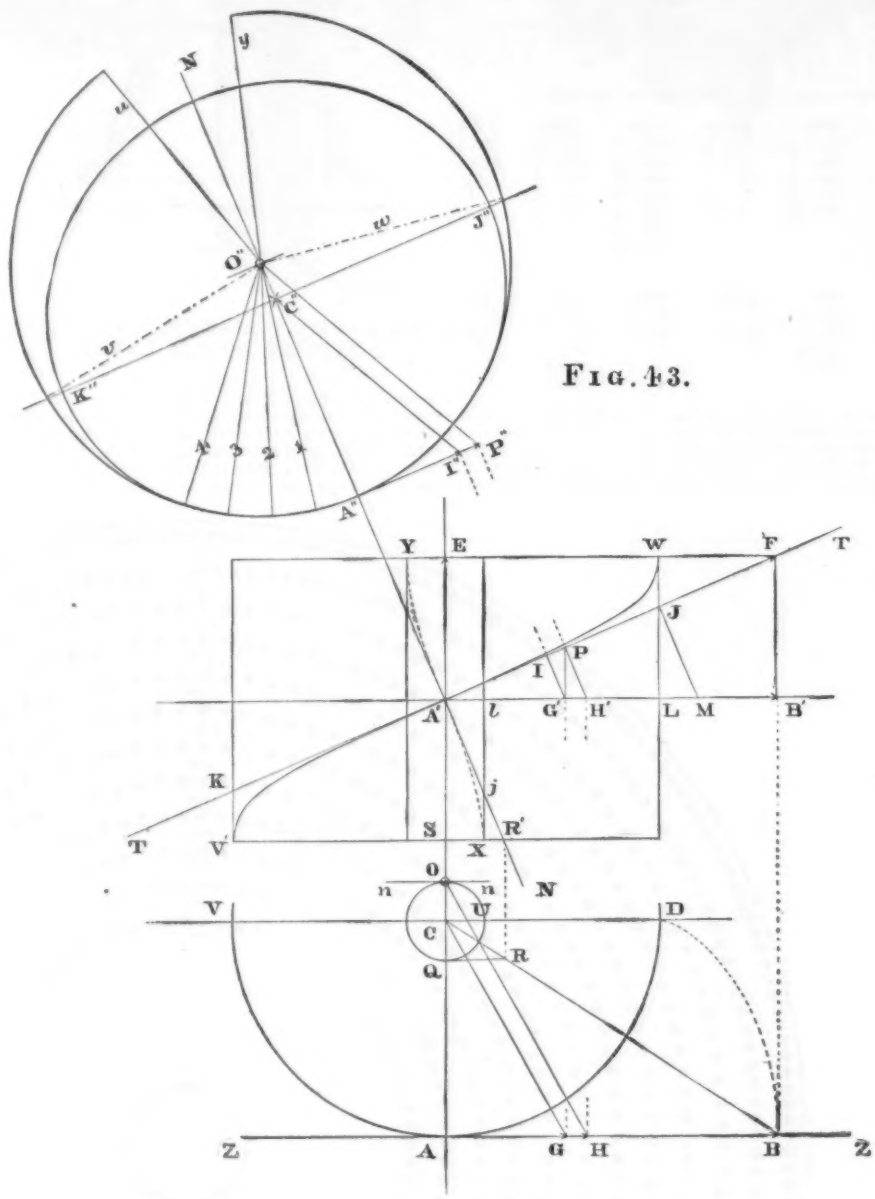


FIG. 43.

out of the wire" without straightening it, and the helix transformed into a plane curve instead of into a right line.

In order to effect this, the successive radii of curvature must be brought, one after the other, into the same plane, and since all these radii are equal, and each pair of consecutive ones meet the evolute in consecutive points of the osculating circle, it would appear, *prima facie*, that the development thus must be a circular arc.

This may perhaps be made more obvious by the aid of the diagram, thus: In the projection upon the plane, T T, let 1, 2, 3, 4 be consecutive radii of curvature, and let A″ O″ lie in the plane. The tangent at A″, which also lies in this plane, contains the consecutive point of the helix, which is the outer extremity of radius 1; the inner extremity, or consecutive center of curvature, does not lie in T T, but in the plane N N. Now, let the helix revolve first about the tangent at A″, until radius 1 comes into the plane T T, and then about that radius until the next point of the helix comes into the plane. Set it, then revolve about the tangent at the outer extremity of 1, until the inner extremity of radius 2 comes into the plane, and so on. It will be apparent that thus all the centers of curvature will be brought one after the other to the same point, O″, in the plane T T, and since they are equal, the points of the helix must fall in a circle about that point.

Confining attention to the quadrant, A′ V′, in the vertical projection, it will be seen that while at first the rotations about the radii, 1, 2, 3, etc., tend to carry the point A″ away from the plane, T T, the rotations about the tangents at the extremities of those points tend to

carry it toward that plane. And it is easily seen that the latter effect increases as the rolling progresses, so that a limit will presently be reached when the point A' will be brought back to the plane.

Beyond this limit, then, the true rolling of a coil of a wire spring upon a table, as suggested above, could not continue. But if we suppose the wire to be cut off, bit by bit, after measuring itself off, any length of the helix may be thus developed into an arc of a circle. In Fig. 43, the dotted radii, *w*, *v*, limit the development of the half turn W A' V', and the full lines *u*, *y*, limit that of one complete coil, of which A' is the middle point.

The angle F A' B' measures the obliquity of the helix V' A' W'; and it is apparent on inspection that the diameter of the cylinder upon which its evolute lies, is dependent on this obliquity; we have

$$\frac{A'\,l}{J\,L} = \frac{j\,l}{A'\,L} \quad \therefore A'\,l = \frac{J\,L \cdot j\,l}{A'\,L} = \frac{J\,L^2}{A'\,L}$$

If then the obliquity becomes zero, A' *l* will vanish; as it should, since at that limit the helix becomes a circle; if the obliquity becomes infinite, the helix degenerates into the axis, and A' *l* becomes infinite, which the radius of curvature of a right line must be. When the obliquity is 45°, the two helices lie on the same cylinder, in the manner of two threads on a double-threaded screw; and the radius of curvature is equal to the diameter of that cylinder.

THE REVOLVING PURIFIER.

THE remarkable effect of metallic iron upon organic matter, and its property of removing color from peaty water, has long been known. Until recently, however, its practical application to large volumes of water has remained an insuperable difficulty, the metal having been used as a filtering medium, in which form it becomes rapidly caked together and loses its permeability after a few months' working. Its valuable properties are utilized in a very different manner in the revolving purifier which we illustrate. This purifier is the invention of Mr. William Anderson, C.E., and was devised for purifying the water supply of Antwerp, Messrs. Easton & Anderson being the engineers for the water works of that city. The principle of the revolving purifier consists in the production of an intimate contact between metallic iron and the liquid to be purified, by the showering down of finely divided particles of the metal through an onward-flowing stream of the liquid. The apparatus consists of a cylinder, A (Fig. 1), supported by hollow trunnions, B1 B2, revolving in pedestal bearings, C1 C2, placed one at each of its extremities. Within the cylinder are a series of short curved shelves, D D (Fig. 2), arranged in steps at equal distances around its circumference, and reaching from end to end. In the place of a sixth row of curved shelves is a line of small square plates, H H, which, by means of nuts outside the cylinder, can be set at an angle with the axis of the purifier. These plates serve to direct the shower of iron back toward the inlet end of the apparatus, and so to counteract the tendency of the current of water to carry the purifying material forward. Through the hollow trunnions, which are provided with stuffing boxes, pass the ends of inlet and outlet pipes, E and F, which bring and which carry off the water to be purified. Facing the inlet pipe, E, is a circular distributing plate, G, secured at a distance of ⅝ inch or ¾ inch from the end of the cylinder, serving to distribute the water radially on its entering the cylinder, and to prevent its flowing in a direct current along the axis of the apparatus. The inner end of the outlet pipe is fitted with an inverted bell-mouth, K, carried down as near to the bottom of the cylinder as the shelves will allow, and intended to prevent the finer particles of iron from being carried out by the current of water. A rotary motion is given to the cylinder through gearing working into an annular spur-wheel, I, surrounding one end of the cylinder. Through a manhole, J, iron in a moderately fine state of division is introduced into the cylinder and spread evenly along the bottom in sufficient quantity to occupy one-tenth of the capacity of the cylinder.

When the purifier is to be set in motion, the sluice-cock, L, at the inlet, is opened and the cylinder filled with water, the air being expelled through the air cock, M, which at that time must be at the top of the cylinder. When all the air is expelled, the air cock is shut, and the apparatus is set in motion by a small steam engine or other motor, the speed of rotation being about six feet per minute at the periphery. By this rotary movement the shelves are successively caused to scoop up the iron granules, which at starting are spread evenly along the bottom of the cylinder, and to shower them down through the water. By means of the sluice cock the flow of water may be regulated to the speed required to give the duration of contact with the iron found necessary for efficient purification under the particular circumstances. On issuing from the purifier the water or sewage under treatment is charged with a soluble ferrous salt, which immediately begins to change into the insoluble ferric oxide by the process of oxidation due to its contact with the air. The rapidity with which this precipitate forms varies considerably, according to the nature of the liquid being purified. With most ordinary river waters the aeration obtained by running along an open trough or channel of moderate length is sufficient, the water being discharged from the trough on to a shallow sand filter, by which the precipitated oxide may be rapidly strained out, leaving the water fit for consumption. The success of this filter has been proved by experience of its application on a large scale at Antwerp, Dordrecht, Gouda, in Holland; at Paris, Nancy, and Libourne, in France; and at Baroda and Agra, in India; in all of which places, Paris and Nancy excepted, the whole water supply is being purified by this process. A complete plant, capable of treating 4,000,000 gallons per day, has also just been adopted for the Montevideo water works. It is introduced by the Revolving Purifier Company, of Dock House, Billiter Street, London.—*Iron.*

THE ARTESIAN WELL SYSTEM OF MEMPHIS.

A CORRESPONDENT of *Fire and Water* describes the Memphis, Tenn., artesian well system as follows: It is probably the greatest system of this kind in the world and the only one of the kind upon which as large a

WELLS AND PUMP HOUSE, MEMPHIS WATER WORKS.

community depends entirely for its water supply. The sinking of the wells has been in progress for some time, and after most careful superintendence and earnest work on the part of the contractors, the Artesian Water Company has at last to be congratulated upon the undoubted success which has attended the scheme. The obtaining of water from this source was at best but an experiment and experienced men declared it impracticable, but the wisdom of the company in carrying out the plan is now beyond dispute.

The following will show the extent of the work and its completeness of detail, and the accompanying diagram the location of wells and pump house. The plant now in operation has a capacity of 13,000,000 gallons daily, and at the old Wolf River plant there is a reserve of 800,000 gallons in case of fire. The sources of supply are thirty-eight artesian wells, each eight inches in diameter and with an average depth of 475 feet. These are connected at a depth of eighty feet with a tunnel 3,500 feet long and five feet in diameter, constructed of Portland cement and hard brick. This tunnel leads to the dry well at the pump house, whence it is pumped for distribution. The dry well is thirty-eight feet in diameter by forty-five feet in depth, and is constructed in the same manner as the tunnel, with Portland cement and hard brick. A framework or caisson of the size of the well was constructed and lowered as the excavation progressed, and the masonry built upon its lines. The foundation and floor of the well is eleven feet thick, of solid concrete. In the center of this well a second or wet well ten feet in diameter has been constructed, which will supply the pumps.

These engines were built by H. R. Worthington. They are three in number, and have each a daily capacity of 10,000,000 gallons. Space has been arranged for a fourth pump in case of necessity. One engine is sufficient to supply the demands of the city at present, so that two are always in reserve. These pumping engines are known as the Worthington compound condensing vertical high duty engines, and designed to work at a piston speed of 123 feet per minute against a head of 250 feet. Their dimensions are:

High pressure steam cylinders, thirty inches in diameter; low pressure steam cylinders, five feet in diameter; double acting water plungers, each twenty-seven inches diameter, and all four feet stroke. They are guaranteed to show an economic duty of 110,000,000 foot pounds.

The new design is especially adapted to the perfect development of the water resources of this particular region. The plans of the engines were approved by several of the most prominent water works builders of the country before they were accepted by the company, and they are pronounced as perfect engines of their kind as have ever been constructed in this country. Their aggregate cost is $105,000.

The boilers consist of a battery of twelve of the Heine safety pattern, with a total of 1,800 horse power. They cost $20,000.

With reference to the tunnel system, it may be mentioned that it was constructed with a view of concentrating the flow of the various wells, which are connected with lateral pipes that discharge in this main channel.

The process of tapping the wells when it comes to connecting the laterals is as follows: An expansion India rubber plug will be inserted at the top of the well on the surface of the ground and forced down until it has passed the point at which the connection is desired to be made, eighty feet below. This holds the flow of water in check until the pipe is cut off, a T joint inserted and the lateral connected. The flow from all the wells is thus held back until all the connections are made. Then the plugs can be withdrawn sufficiently to allow the water to escape into the lateral and the tunnel to be filled. These plugs will be retained in each well to prevent any water from escaping to the surface, and for use in case repairs to the tunnel or any of the laterals are necessary.

The pipe system consists of sixty-five miles of pipe now in the ground. About two miles of this is 36 inch, constituting the main pipe, which is the largest in the South, one mile of 30 and 24 inch and five miles of 20 and 16 inch, and the balance of 12, 10, 8 and 6 inch pipe.

There are some 600 gates on the pipe system, 355 hydrants, 5,000 or more service connections, 250 flush tank connections, and at low points there are blow-offs to enable the company to clean out the mains.

The standpipe is 20 feet in diameter and 160 feet high, constructed upon a rock and concrete foundation 48 feet in diameter and 17 feet deep. It is made of steel plates, and is considered one of the finest structures in the United States. The cost was $60,000.

The pump-house is a fine building of very imposing appearance. It is built of hard brick finished with stone and terra cotta. It is 170x75 feet and contains the main or pumping room, boiler room and coal house. The two smoke stacks are 125 feet high, with 13 feet base and 6 feet diameter at top, the inside being lined throughout with fire brick.

The wells were put in by the National Water Supply Company, of Cincinnati, using the Wagner steamed well process, and by the Cook Well Company, of St. Louis. The work of both of these firms was most satisfactory and is a standing testimonial to the energy and ability with which they carried out their contracts. The designing engineer is Thomas T. Johnson.

The company's superintendent, W. L. Cameron, is well known to the water works people, especially to members of the American Water Works Association, as one of the brightest men in the profession. Under his intelligent supervision the company can rest assured their novel and valuable system will be carefully guarded. In reply to a question put to the superintendent as to the new water works, came the following characteristic reply:

"On the first of January, when the new plant of the Water Company is completed, Memphis can boast of the finest water works in the United States, whether as regards the pipe system, machinery or quality of water distributed, and this assertion I make after eighteen years' experience and a knowledge of all the important water systems in the country."

The company will spend over $800,000 on these new works, and several new mains and connections will be put in at once.

The officers of the company are: T. J. Latham president; Z. C. Graves, vice-president; W. L. Cameron, superintendent; and Lawrence Simpson, secretary.

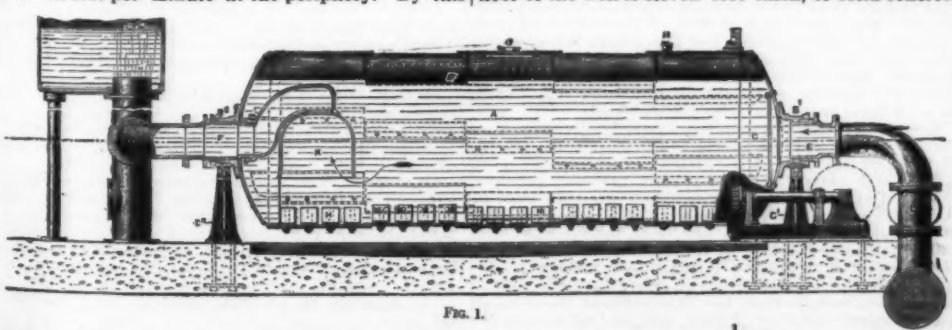


FIG. 1.

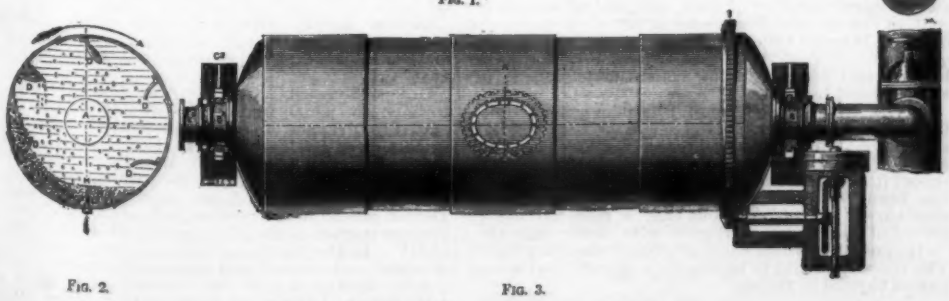


FIG. 2. FIG. 3.

THE REVOLVING PURIFIER.

NOTES ON ESSENTIAL OILS.

THE following notes on various essential oils are taken from the October Report of Messrs. Schimmel & Co., of Leipzig:

ANGELICA ROOT OIL (Japanese).—Information has been received from Mr. Murai, Tokio, that the *Angelica anomala*, Lall. s. *Angelica Japonica*, A. Gray (Jap. "*Biyakushi*"), referred to particularly in the last report (*Pharm. Journ.*, April 6, p. 803), is cultivated in Japan on account of its roots. Mr. Murai's experience as to the oil contents of the root corresponds with that of Messrs. Schimmel. From roots cultivated at the botanical station in Tokio he obtained 0·074 per cent., and from seed 0·67 per cent. The oil was of a greenish color and had a very strong odor, resembling that of musk. In winter a solid white mass separated.

ARNICA FLOWERS OIL.—The specific gravity of this oil is given as 0·906 at 15° C. The oil is said to be a liquid and not of a butter-like consistence, which form it assumes only upon undergoing a cooling.

BAY OIL.—A sample of oil distilled from leaves imported direct from St. Thomas has been examined by Dr. Mittmann, in Breslau, who found eugenol to be the principal constituent; the methyl ether of eugenol was also present in small quantity as well as pinene and probably dipentene and diterpene. The specific gravity at 15° C. was 0·970. The oil dissolved clear only in

ether, petroleum ether, carbon bisulphide, and chloroform, while with alcohol and glacial acetic acid it gave a strong turbidity. In preparing "bay rum" from bay oil, therefore, the solution may prove turbid and require to be filtered or treated with magnesia.

BETEL OIL.—The isomer of eugenol mentioned in the last report (*Pharm. Journ.*, April 6, p. 803) as occurring in the oil of betel leaves has now been definitely named "betelphenol." The other important constituent of the oil is a sesquiterpene identical with that already detected in the oils of cubebs, savin, patchouli, and camphor.

CASSIA OIL.—Several pages in the present report are devoted to the controversy that has arisen upon the statements made by Messrs. Schimmel respecting the adulteration of certain brands of cassia oil (*Pharm. Journ.*, April 20, p. 842). It will be remembered that samples of oil that had been certified by the proprietor of a "Medical Hall" in Hongkong as being pure and completely volatile were reported by Messrs. Schimmel to contain an ingredient that they had identified as petroleum, and to leave on redistillation 35 per cent. of a solid residue that had been recognized as pitch resin. It appears that this report has drawn from the person responsible for the certificate, a Mr. Niedhardt, an assertion that Messrs. Schimmel's chemists have mistaken for petroleum a light hydrocarbon that is a natural constituent of genuine cassia oil, and that the resin was a natural product of alteration in the oil, which occurs to the extent of 30 or 40 per cent., even in an oil only a year old. In respect to the first point Messrs. Schimmel protest against it being supposed that their chemists, who are engaged every day in dealing with essential oils, would confound with petroleum a terpene. Moreover, they state that after purification the substance in question has a specific gravity of 0·795 at 20° C., being considerably lower than that of any known terpene; also that it boils between 160° and 265° C., and is indifferent toward sulphuric acid. As to the solid residue, it is pertinently asked how an oil that contained so much resin, even if that were a natural constituent, could be certified as "perfectly volatile." But the prevailing scarcity of pure cassia oil has had the effect of bringing into the market some old stocks, and afforded Messrs. Schimmel an opportunity of examining samples from seventy cases said to have been warehoused in Amsterdam for from nine to seventy years. These, whether distilled in a retort over an open fire or rectified by steam, gave as a distillate a clear oil, and the residuum, which varied from 5·5 to 8 per cent., was in every case liquid and did not solidify. Cassia oil distilled in Messrs. Schimmel's establishment from cassia chips, when redistilled at the end of four months, yielded 5·4 per cent. of liquid residue, and an oil of the same age, from cassia buds, gave 4·4 per cent. of liquid residue. As the result of this experience the opinion is expressed that a good merchantable cassia oil should answer to the following characters: (1) It should have at 15° C. a specific gravity of 1·050 to 1·070. (2) Upon distilling, about 90 per cent. of pure cassia oil should pass over, and the residue, which may amount to 6 or 7 per cent., and in no case to more than 10 per cent., should not become solid and assume a resinous appearance on cooling, but should remain semi-liquid at least. Experiment has shown that no practical value as a test attaches to the relative solubility of cassia oil in alcohol when it contains an admixture of resin and petroleum.

It is thought that the determination of the value of mercantile cassia oils on a scientific basis will have to depend upon the quantity of cinnamic aldehyd contained in them. The percentages of cinnamic aldehyd obtained at present are as follows:

a. Pure Oils.

1.	Home distillation from cassia chips....	88·9
2.	Home distillation from cassia buds ...	80·4
3.	Brand "Ayong," age 60 to 80 years.. ..	76·0
4.	Brand "Ayong," age 24 years.....	72·9
5.	Brand "Ayong," age 20 years	89·4
6.	Brand "Hop Lee," very old.....	76·6
7.	Brand "Tac Foong," very old	78·4

b. Adulterated Oils.

8.	Brand "Yan Loong," 1st lot	58
9.	Brand "Yan Loong," 2d lot..	63·2
10.	Brand "Cheong Loong," 1st lot.....	58·7
11.	Brand "Cheong Loong," 2d lot	52·9
12.	Brand "Cheong Loong," 3d lot.....	57·8
13.	Brand "Luen Tai".....	47·1

The amount of cinnamic aldehyd in these oils was found by determining the percentage of non-aldehyds after separating the aldehyd by means of sodium bisulphite, but some skill is necessary to obtain exact results. The results show that the amount of cinnamic aldehyd is smaller in proportion to the increase in adulteration. Further investigation will be required, but at present it may be stated that a cassia oil that contains less than 70 per cent. of cinnamic aldehyd may be considered adulterated, and that probably an oil containing less than 75 per cent. should be looked upon with suspicion. For instance, a sample of oil, brand "Ayong," age 9 years, which yielded 79 per cent. of cinnamic aldehyd, left a liquid residue from which 10 per cent. of fixed oil was separated, so that before it was readulterated this oil would have shown nearly 90 per cent. of aldehyd.

The principal non-aldehyd constituent of cassia oil has been ascertained by repeated fractionation to be the acetic ether of cinnamyl, $C_2H_3O_2.C_9H_9$, the portion boiling between 135° and 145° C. (at 11 mm. atmospheric pressure) consisting entirely of that ether. The cinnamic alcohol, obtained by saponification, crystallizes from ether in white solid crystals, boils at 137° C. (at 11 mm. pressure), and has a "somewhat hyacinth odor." The presence of the acetic ether of phenylpropyl is also probable. Terpenes of the constitution $C_{10}H_{16}$ are not present, but probably sesquiterpenes and polyterpenes are. Free cinnamic acid, formed by oxidation of cinnamic aldehyd in contact with air, was found both in old oils and those freshly distilled, but always in small proportion.

CITRONELLE OIL.—Two years since Messrs. Schimmel called attention to the adulteration of citronelle oil with petroleum, and they now state that since that time the adulteration has gone on with increasing audacity. Fortunately a ready test for the adulteration is available in the behavior of the oil toward alcohol. Experiment with specially distilled oil has shown that the solubility of the citronelle containing only a small quantity of petroleum is pretty large, but that upon the addition of more petroleum it diminishes rapidly. The test recommended is that one part of the oil should give a clear solution with ten parts of 80 per cent. alcohol, when shaken vigorously. In the presence of 10 per cent. of petroleum the mixture becomes milky. An addition of a fixed oil is still more perceptible, as little as 1 or 2 per cent. being recognizable, but the mixture becomes turbid rather than milky. The specific gravity of the oil should not be below 0·895 at 15° C.

CLOVE OIL.—Criticising the specific gravity of 1·041 to 1·060 given in the *German Pharmacopœia* for oil of cloves, Messrs. Schimmel state as their experience that genuine oil of cloves has a specific gravity of 1·067, and oil of clove stalks one of 1·083. They, therefore, think the requirement should be altered to a specific gravity of not under 1·060.

ELEMI OIL.—Oil distilled from elemi resin by Messrs. Schimmel has been examined by O. Wallach, who found it to have a specific gravity of 0·900 and to be dextro-rotatory. It contains considerable quantities of right-handed phellandrene, while in the portion boiling between 175° and 180° C. there is so large a quantity of dipentene that the oil would appear suited for the preparation of dipentene compounds. In addition there is a large quantity of constituents having higher boiling points, and the amyrin of the resin appears to be represented in the oil.

EUCALYPTUS OIL.—Some oil that has been received from Australia as a product from *Eucalyptus odorata* is spoken of very favorably. It has a specific gravity of 0·907 at 15° C., and gives with hydrobromic acid a strong eucalyptol reaction. It is said to answer to the requirements of a good oil and to be as suitable for therapeutic purposes as the oil of *Eucalyptus Globulus*. This Australian oil is packed somewhat differently from the *E. amygdalina* oil hitherto received, the case containing four tins, each holding 18 lb. of oil. From the south of Spain an oil of *E. Globulus* has been received that is so rich in eucalyptol, or cineol, that upon placing it in a cooling mixture it solidifies to a paste. It has a specific gravity of 0·931 at 15° C. The Californian oil from *E. Globulus* is reported to have shown lately considerable variation in the amount of eucalyptol it contained, probably on account of some having been removed. A normal oil should contain from 50 to 70 per cent. of eucalyptol. The oil of *Eucalyptus dumosa* also contains a large quantity of eucalyptol.

FENNEL (Japanese).—Under the name "anise" a sample of Japanese fennel has made its appearance in the market, which although it has the aroma and taste of fennel, presented an extraordinary similarity to anise in the form and size of the grain. Any doubt that might have existed was removed by the plants that resulted from sowing some of the seed. According to Rein, the Japanese fennel is derived from the same species as the European—*Fœniculum vulgare*, Gaertner (*F. capillaceum*, Gilibert)—and is much used in Japan as a pastry spice. Arrangements have been made for a supply of the seeds with a view of examining the oil that they yield.

KESSO ROOT OIL.—The oil distilled from the Japanese "kesso" roots (*Valeriana officinalis*, L., var. *angustifolia*) is, in Messrs. Schimmel's opinion, probably to be esteemed quite equal in its practical characters to the German distillate, and may be used unreservedly in its place for technical purposes. The high specific gravity of the kesso oil is attributed to the presence of a heavy constituent having a high boiling point, which is at present unknown and has not been observed in ordinary valerian oil.

KURO-MOJI OIL.—Further information has been received from Japan respecting the kuro-moji oil referred to in the last previous report (*Pharm. Journ.*, April 20, p. 844). Mr. Murai, of the Sanitary Laboratory, Tokio, writes that the oil was unknown in the Japanese market until the last few years, but the plant from which it is derived (*Lindera sericea*, Blume) is a tree indigenous in every district in the country. The wood, together with the bark of the tree, is used in the preparation of a dentifrice on account of its pleasant odor.

OLIBANUM OIL.—Wallach has found that the terpene of this oil, which has hitherto been called "olibene," is identical with pinene, and further that the oil also contains a small quantity of dipentene.

ORANGE FLOWER OIL.—An interesting experiment has been made this year in the transmission of freshly picked orange flowers from the south of Spain to Germany. The flowers were packed in casks, from which the air was pumped out after filling, and are said to have borne their transport well. They proved to have been gathered from the sweet orange (*Citrus vulgaris*) and yielded the known, but not esteemed, neroli-portugal oil. From 800 kilos. of flowers 1·150 kilos. of pure essential oil was obtained, but the orange flower water produced was worthless. The bitter orange (*Citrus vulgaris*, Risso; *Citrus aurantium amara*, L.), which yields the fine orange flower oil and water, appears to be only little cultivated in southern Spain.

ROSEMARY OIL.—A sample of pure Italian rosemary oil of the year 1887 was found to have a specific gravity of 0·902, 89 per cent. of it distilled at a temperature of 200° C. and under, and 5 per cent. between 200° and 220° C. A sample of the year 1888 had a specific gravity of 0·905; 88 per cent. passed over at a temperature of 200° C. and under, and 6 per cent. between 200° and 220° C. These data are of importance in view of the fact that oil of rosemary is now used largely in Germany for the denaturizing of spirit, and the official regulations require that for this purpose the oil shall have a specific gravity of 0·900, and that at least 90 per cent. of the oil shall distill over at 200° C. It is pointed out that in order bring a genuine oil within these requirements it would be necessary to remove part of the heavier and higher boiling constituents, which are camphor and borneol.

THYME OIL.—The German Pharmacopœia requires that oil of thyme when dissolved in half its weight of spirit should not give a yellowish red color upon the addition of a drop of ferric chloride solution. In this report it is stated that an oil from which the thymol has been removed by shaking it with soda solution may answer to this test, but that a pure oil, not deprived of its thymol, will give with ferric chloride a dirty, greenish brown color, afterward changing to red. The reaction is said to be due to a phenol that accompanies thymol in the oil.

The novelties mentioned in this report are as follows:

GARLIC OIL.—From bulbs of *Allium sativum*, L. From 900 kilos. of raw material Messrs. Schimmel obtained 800 grammes of a pure oil, having an intense odor and taste of garlic, which it is thought might be used in the preparation of piquant sauces, pickles, etc. Experiment seemed to show 10 grammes of the oil to be equal to about 11 kilos. of fresh garlic. The oil has a specific gravity of 1·053 at 15° C., and is to be further investigated.

SPANISH OILS.—The following essential oils have been received from a newly established manufactory in the province of Granada, in the south of Spain. The information immediately following the name has been supplied by the distillers. Some remarks by Messrs. Schimmel are inclosed between brackets:

OLEUM ARISTOLOCHIÆ SUBGLAUCÆ.—Distilled from the fresh flowering shoots of *Aristolochia subglauca*, Lank. et Brot. (*A. glauca*, Desf.) The yield of oil is very low and the plant is not widely distributed. The oil is used as an emmenagogue. [Has a disagreeable valerian-like odor. Useless for perfumery purposes.]

OLEUM ARTEMISIÆ BARELLIERI.—This oil, obtained from the dried flower racemes and fresh young sfioots, might probably be used as a substitute for oil of wormwood. This species of *Artemisia* yields a carminative used in the district apparently with good results in colic (even in severe lead colic) and hysterical and epileptic attacks. [Sp. gr. 0·923 at 15°. Boils between 180° and 210°. In odor this oil resembles strongly oil of tansy, it being agreeably and powerfully aromatic.]

OLEUM ARTEMISIÆ HISPANICÆ.—Distilled from the fresh young shoots of *Artemisia hispanica*, which although somewhat less frequent than *A. Barellieri*, would allow of the production of a considerable quantity of oil. Both species are said to be used in the manufacture of Algerian absinthe. The plant is popularly reputed to exercise a depressing influence on the genital organs. [This oil would be difficult to make use of practically. In odor it somewhat resembles wild fennel.]

OLEUM CISTI LADANIFERI.—Obtained from the leaves, a decoction of which is used generally against rheumatism, syphilitic complaints, and affections of the respiratory organs. [Sp. gr. 0·925 at 15° C. Boils between 165° and 280° under partial decomposition, with a strong odor of acetic acid. The odor of the oil is unpleasantly narcotic and stupefying. The laudanum is said to be obtained in Spain by boiling the branches.]

OLEUM FŒNICULI.—From the young shoots of the wild fennel, which attains in the district a height exceeding two meters. [This oil is identical with the so-called "bitter fennel oil," as distilled in the south of France.]

OLEUM HELICHRYSI STŒCHADIS.—Obtained from the flowering plant, which is used in bladder and kidney affections. [About three-fourths boils between 155° and 170°, and one-fourth between 170° and 260°. Specific gravity 0·873 at 15° C. The oil has an odor similar to that of the distillates of the smaller coniferæ. Most probably contains much pinene.]

OLEUM LAVENDULÆ DENTATÆ.—The therapeutic properties attributed to previous oils of this class are alleged to be possessed by this oil in even a still higher degree. It is said to promote the healing of sluggish wounds, and when used in the form of inhalation to have given good results in severe catarrh and in two cases of diphtheria. [Specific gravity 0·926 at 15° C. It distills almost completely between 170° and 200°. Cineol was detected in it. In odor it strongly suggests rosemary oil and camphor.]

OLEUM LAVANDULÆ STŒCHADIS FLOR.—Obtained from the freshly collected flowering tops of *Lavandula stœchas*. The plant is known in Spain as "romero santo" (sacred rosemary), and its essential oil, as well as that of *L. dentata*, is obtained for household use by suspending the fresh flowering stalks, flowers downward, in closed bottles and exposing them for some time to the sun's rays. A mixture collects at the bottom of water and essential oil, which is used as a hæmostatic and for cleansing wounds. [Sp. gr. 0·942 at 15° C. Boils between 180° and 245°, cineol being present in the lowest boiling fraction. The odor of the oil in no way suggests that of lavender, but resembles more that of oil of rosemary, with which it has the camphoraceous smell in common.

OLEUM MARRUBII ALYSSON.—Obtained from the flowering tops of *M. Alysson*, L., var. *lanatum*, Casson. The plant has a reputation as a remedy for affections of the chest and throat, and possibly possesses febrifuge properties.

OLEUM MENTHÆ AQUATICÆ.—From the fresh young shoots of the water mint, which in some of the ravine districts of South Spain grows abundantly and luxuriantly to a height of two meters. [Yellowish-green oil, with a pennyroyal-like mint odor.]

OLEUM ROSEMARINÆ.—Obtained from freshly collected young shoots and leaves. [In parallel experiments it was ascertained that this Spanish oil contains the same constituents as French oil of rosemary, but in different proportions. Pinene was recognized through the pinene-nitrol-piperidin compound, m. p. 118° C. Specific gravity of the oil 0·892 at 15°. The oil is scarcely to be distinguished from fine French oil.]

OLEUM RUTÆ.—Obtained from fresh flowering stalks of *Ruta graveolens*, attaining a height of 1½ meters. [This oil is superior in quality. Sp. gr. 0·859 at 15° C.]

OLEUM SATUREJÆ THYMBRÆ.—Obtained from the fresh herb, which by the ancient Greeks was consecrated to Pryapos, and in Spain is used generally as a spice, and especially for olives. It has also a reputation as a powerful stimulant and disinfectant. [The oil has a specific gravity of 0·906 at 15° and contains 19 per cent. of thymol. Upon careful fractionation it yielded pinene in the portion boiling at 160°, but the greater portion of the oil consisted of cymol, boiling at 175°. In the following fraction a small quantity of dipentene was found, and upon saponification of the portion boiling at over 200° borneol and acetic acid were obtained, these two bodies consequently existing in the oil in the form of the acetic acid bornyl ether.

The oil has an extremely powerful and penetrating thymol odor.]

OLEUM SOLIDAGINIS.—Distilled from the fresh young shoots of a species of *Solidago* growing in the south of Spain to a height of 2 meters, and popularly esteemed as a hæmostatic and blood purifier. The yield of oil is small. [The oil has an aromatic and somewhat mint-like odor, like that of the American golden rod oil. Practically it has scarcely any value.]

OLEUM TEUCRII FUNKIANI.—Distilled from the flowering herb of the strongly aromatic bitter *T. Funkianum*, Willk. The collection of the plant is expensive and the yield of oil small. [The oil has an undefinable odor.]

OLEUM THYMI CAPITATI.—Prepared from the freshly mowed herb of the classic honey plant of Mount Hymettus. The freshly distilled oil has a specific gravity of 0·888 at 18° C. A characteristic reaction of the oil is that when shaken with water it imparts to the latter a peach-red color. [The oil much resembles in its composition the oleum saturejæ thymbræ. It has a specific gravity of 0·901 at 15° C., but the quantity of thymol is considerably smaller, amounting to about 6 per cent. Besides thymol there is present another liquid phenol, the boiling point of which is near to that of thymol. The other constituents are the same as those in the oil of *Satureja Thymbra*, consisting of pinene, cymol, dipentene, and acetic acid bornyl ether. The oil has a powerful thyme-like odor recalling that of origanum.

ANDROPOGON FRAGRANS OIL.—Under the name "Huile essentielle de Pataque Malgache" a new oil has been introduced from the island of Reunion, which is represented to be a distillate from *Andropogon fragrans*. It is a yellowish thick liquid having an odour undistinguishable from that of East Indian ginger grass oil (*Andropogon Shœnanthus*).

[REPORTS FROM THE CONSULS OF THE UNITED STATES.]

COOKERY FOR WORKINGMEN'S WIVES.*

Report by Consul UNDERWOOD, of Glasgow.

Pea Soup and Potatoes.—One pound split peas, 1½*d.*; vegetables, 1½*d.*; one fourth stone potatoes, 1½*d.*; total, 4½*d.*

Wash the peas, and leave them soak overnight; put them on with 1 gallon of the water in which they were soaked, and the onions cut fine; boil for one hour and a half, add carrot and turnip and two potatoes, all grated; boil for another half hour, then add a teaspoonful of powdered mint, and serve hot. To be taken with potatoes.

Barley Broth.—One pound mutton or beef bones, 1*d.*; one-half pound barley, 1*d.*; one-half pound peas, 1*d.*; cabbage, turnip, carrot, parsnip, leeks, parsley, and celery, 1*d.*; total, 4d. In most places an assorted lot of vegetables can be got for 1*d.* or 2*d.*, according to quantity.

Nothing can be more nourishing or wholesome than broth. It is advisable to make sufficient for two days, as many think the second day's broth warmed up is the best. It can be made of beef or mutton. The neck of mutton makes very sweet broth, but some prefer a cut of boiling beef with marrow. Be sure to have a pot with a good fitting lid. Put on the meat with 2 gallons of water, barley, and peas (if peas are used, they must be soaked the night before), and boil for one hour, then add the cabbage, turnip, carrot, and parsnip, cut small, and part of the carrot grated. Boil very slowly with lid closed for half an hour, then add leeks, parsley, and celery; boil for another half hour; in all, boil for two hours, and serve.

Sheep's Head Broth.—Head and trotters, 6*d.*; barley and peas, 1*d.*; mixed vegetables, 1½*d.*; total, 8½*d.*

Get head and trotters singed; have the head split, take out the brains, wash every part well; pierce the eyes, and wash the skin with the liquor that flows out; scrape out the eye cavities with a knife, then put the head and trotters in a pail of clean water, with a little salt and soda; let them steep all night; take them out, and scrape them well; put them in the pot with 1 gallon of water, a teacupful of peas and three-quarters of a teacupful of barley, boil for three-quarters of an hour; add half a turnip cut in slices, the other half with carrot, parsnip, and cabbage cut very small, boil for an hour; add leeks, celery, parsley cut small, and boil for another hour; dish the broth, and serve head and trotters with the slices of turnip for garnish. Sheep's head broth requires longer boiling than other broths.

Fish Soup.—Cod head, 1*d.*; vegetables (carrot, onion, and parsley), 1½*d.*; one-half pound of rice, ½*d.*; one-half stone potatoes, 2*d.*; total 6*d.*

Get a large cod head, wash it well; put it on with cold water (1 gallon), and boil for an hour, then put it through a sieve or clean coarse cloth; wash the rice well, and add; cut the onions very fine, and add; grate the carrot, and boil very slowly with lid closed for an hour; then add chopped parsley and all the fish taken from the head, with pepper and salt to taste. Serve hot with potatoes. A little milk will improve the soup. It is very like oyster soup.

Mock Kidney Soup and Potatoes.—Two pounds of liver, 6*d.*; vegetables (carrot, turnip, onion), 1*d.*; one-half stone potatoes, 3*d.*; total, 10*d.*

Put on half of the liver with 1 gallon of water; boil very slowly for an hour, then take it out and grate it; have the other half cut in nice, small pieces, and add; grate the carrot and turnip, and one potato, but do not add the potato until fifteen minutes before you take the soup off the fire; cut the onion very fine, and add it with the liver, carrot, and turnip; boil very slowly for one and one-half hours with lid close. Pepper and salt to taste, and serve with hot potatoes.

Potato Soup and Fried Beans.—One-fourth stone potatoes, 1½*d.*; bone, 1*d.*; vegetables, 1*d.*; 1 pound haricot beans, 1½*d.*; two ounces dripping, ¾*d.*; onions, ½*d.*; total, 6*d.*

Boil the bone for six hours in 1 gallon of water; cut the potatoes in six, and add; cut leeks fine, grate carrot and turnip, and add; boil for an hour with lid very close, then add a little parsley cut fine; pepper and salt to taste. Serve hot.

Beans: Soak the beans for sixteen hours, then boil them for two and one-half hours; drain them; have a hot pan ready, put in dripping, with onion cut fine, then add beans, and fry till of a pale golden brown.

Rice Soup and Baked Haricot Beans.—One-half pound rice, ½*d.*; bone, 1*d.*; vegetables, 1*d.*; 1 pound beans, 1½*d.*; onions, ½*d.*; 2 ounces dripping, ¾*d.*; salt and pepper to taste; total, 5½*d.*

Soup: boil the bone for six hours. When you are going to make your soup, see that you have a gallon of the water that the bone was boiled in; add the rice, carrot, and turnip, grated, leek cut up small, and a little parsley cut up fine; boil for one hour; pepper and salt to taste.

Beans: Soak the beans overnight; put them and the onions cut fine into a dish; salt and pepper to taste; add dripping and a pint of water; cover with a close-fitting lid, and bake in a slow oven for six hours. A most nutritious and savory dinner.

Rice Soup, Tripe, and Potatoes.—Sheep's bag, 2½*d.*; one-half pound rice, ½*d.*; vegetables, 1*d.*; one-fourth stone potatoes, 1½*d.*; total, 5½*d.*

Clean the tripe well, and boil it slowly for five hours; take it out, and cut it up into small pieces, and put it into another saucepan with a pint of stock, keep lid close; let it simmer for two hours; to remainder of stock add water to make one gallon, add rice, and let it boil for half an hour slowly; cut leeks and parsley fine, grate carrot, and add; boil for another half-hour, and serve hot, with salt and pepper to taste. Serve tripe with potatoes.

Haricot Bean Soup and Potatoes.—One-fourth stone potatoes, 1½*d.*; 1 pound beans, 1½*d.*; vegetables, 1*d.*; onion, ½*d.*; one-fourth stone potatoes, 1½*d.*; total, 6*d.*

Wash the beans, and leave them to soak for sixteen hours. Put into a clean pot with a gallon of water and the onion cut fine. Boil very carefully and slowly for two hours, then add carrot, turnip, and two potatoes, all grated, and boil for half an hour. Just before serving add a teaspoonful of powdered sage; salt and pepper to taste. Serve hot. To be taken with potatoes.

Mulligatawny Soup.—A calf's head and feet, 4*d.*; pepper, salt, carrot, and turnip, 1*d.*; apple, 1*d.*; onion, marjoram, thyme, curry powder, and sugar, 1*d.*; total, 7*d.*

Scald the head and feet in hot water, having about the size of a nut of soda in the water; then scrape the hair all off, wash clean, and boil for about two hours; then strain the stock through a sieve or cloth; take all the meat from the bones, cut into small dice, and put it back into the soup; add water until you have 1 gallon; then cut the apple, onion, and half of the carrot and turnip into small dice, and fry them in a pan; grate the other half of the turnip and carrot, and add all to the soup, also a teaspoonful of powdered marjoram, curry powder, thyme, and sugar; pepper and salt to taste, and boil for one hour.

Mock Cock-a-leekie (*very good*).—Two pounds veal, 6*d.*; leeks, 2*d.*; four cloves, blade of mace, one-half teaspoonful of celery seed, 1*d.*; total 9*d.*

Boil the veal slowly for two hours in one gallon of water, with the cloves, mace, and celery seed tied up in a muslin bag. When the veal has boiled two hours take it out and add the leeks, well washed and cut fine. Cut up the veal in small pieces, add to the soup. When the leeks have boiled half an hour, add the potato, grated; boil for fifteen minutes; take out the muslin bag. Salt and pepper to taste; serve hot.

Mock Turtle Soup.—Calf's head, a small piece of the lights, 6*d.*; small piece of the liver, one fourth pound fat pork, 2*d.*; 1 teaspoonful of cinnamon, 1 of allspice, one-half of cloves, one half of cayenne pepper, 1*d.*; one lemon, 1*d.*; one-half pound flour, ½*d.*; 3 potatoes, ½*d.*; 3 eggs, 3*d.*; total, 1*s.* 2*d.*

Wash and soak the head, lights, and liver for some hours. Boil them very carefully, keeping the lid close. Cut the meat up into small strips, fry the pork, cut it up into small pieces, and add all to the soup. You should have 1 gallon. When it boils put in the cinnamon, allspice, cloves, and cayenne pepper. Grate the rind of the lemon, add it with the juice to the soup. Grate the three potatoes, and add. Brown the flour before the fire, mix it smooth, and add; let all boil for ten minutes. Have 3 hard-boiled eggs, slice them up into the tureen, and pour the soup on top of them. This recipe is equal to real turtle soup. It can be made with force meat balls, which are an improvement.

Sea Pie and Potatoes.—One pound scrap meat, 5*d.*; vegetables, 1*d.*; suet, 1*d.*; flour, 1*d.*; baking powder; one-fourth stone potatoes, 1½*d.*; total, 9½*d.*

Get nice fresh meat and cut it into small pieces. Wash and cut up onions, carrot, turnip; put into stew pan with two cups of boiling water; set on the fire. Mince suet fine and mix with the flour, a pinch of salt, one-half teaspoonful of baking powder, mix with cold water, roll out paste the size of the pan lid, put it on top of the meat and vegetables, and let all steam for one and one half hours at the side of the fire, not boiling, but at the boil. When done cut the paste in four and take it out with the fork, then the meat and vegetables, and put the paste on top of all as it was in the pot. Serve hot with potatoes.

Potatoes and Stewed Tripe.—Sheep's bag, 2½*d.*; one fourth stone potatoes, 1½*d.*; one-half pound onions, ½*d.*; total, 4½*d.*

Get a sheep's bag and clean it well with hot water, not boiling but very hot, then leave it over night in salt and water, put it on and let it stew very gently for three hours in 2 pints of water. Cut up the onion very small and cut the tripe up into nice pieces; return the tripe to the soup with onion and a large tablespoonful of flour, then stew for another hour. If you can afford it, 1*d.* worth of milk added to this would make it better. Serve hot with potatoes.

"*Hot Pot*," *or Stewed Mutton and Potatoes.*—One pound flank of mutton, 4½*d.*; carrot, turnip, onion, 1*d.*; one-fourth stone potatoes, 1½*d.*; total, 7*d.*

Wash and pare potatoes, cut into four or six; pare turnip, cut in slices; scrape carrot and cut in slices; cut onion fine; cut mutton into small pieces; put a little of it into the bottom of the stew pan, then potatoes, onion, carrot, turnip, mixed with pepper and salt, then some more mutton till all is in; add 1 pint of water, and steam for two hours. Serve hot.

German Pie.—One-fourth stone potatoes, 1½*d.*; red herring, ¾*d.*; 1 pound flour, 1½*d.*; one-fourth pound dripping, 1½*d.*; pepper, salt, baking powder, ¼*d.*; total, 5½*d.*

Wash, pare, and slice potatoes, soak the herring in warm water, and divide into flakes; put the sliced potatoes and herring into a pie dish, well mixed with a little pepper and 1 ounce of dripping. If the herring is not salt, add a little salt, cover, and bake for two hours.

Cover: Mix the flour and 3 ounces of dripping with a teaspoonful of baking powder and a saltspoonful of salt; make a stiff paste with cold water, roll out to the size of pie dish, and cover. Serve hot.

A Good "Poor Man's" Pie.—One-fourth stone pototoes, 1½*d.*; 3 ounces tapioca, ½*d.*; one-half pound onions, ½*d.*; 1 pound flour, 1½*d.*; one-fourth pound dripping, 1½*d.*; pepper, salt, baking powder, ½*d.*; total, 5½*d.*

Mode: Wash, pare, and slice the potatoes. Have the tapioca washed and soaked in cold water for an hour before it is wanted. Cut onion fine. Take 1 ounce of the dripping and put a little in the bottom of a pie dish, then onion, then some of the soaked tapioca, then potatoes, salt and pepper. Repeat till all are in, then cover. Take the 1 pound of flour, 3 ounces dripping, a teaspoonful of baking powder, and a saltspoonful of salt, mix well, and add cold water to make a stiff paste, roll out, and cover. Bake for two hours. Serve hot.

A Good Savory Pie.—One pound of ox liver, 3d.; one-fourth stone potatoes, 1½d.; 1 pound flour, 1½d.; one-fourth pound lard, 1¼d.; pepper, salt, onion, and baking powder, ½d.; total, 8d.

Mode: Cut the liver in small pieces, also the onions. Pare the potatoes very thin, cut in slices, and put them in pie dish in layers with pepper and salt. When all in, add water till three parts full.

Cover: Take flour, lard, a teaspoonful of baking powder, and a saltspoonful of salt; mix well; add cold water to make a paste; roll out and cover pie dish, and bake for two hours.

Stewed Calf's Head and Potatoes.—Calf's head, 4d.; onions, ½d.; potatoes, one-half stone, 3d.; total, 7½d.

Wash the head well and leave it to soak for some hours in water and a little salt. Break up the head. Put it, with 1 quart of water and the onions cut fine, into a nice clean pot. Let it boil, and then only keep it at the boil, without boiling, for three hours, and you have a good savory stew to eat with potatoes.

Lentils and Rice.—One pound lentils, 1½d.; one-half pound rice, ¾d.; onion, ½d.; dripping, ½d.; total, 3d.

Wash the lentils, soak them over night, and put them into a saucepan with 3 quarts of water. Boil for two hours very slowly; then add the rice (after washing it), with onion cut fine and dripping. Let the rice boil until it absorbs all the water. This makes a good substantial dinner.

Rice and Cabbage.—One pound rice, 1½d.; 1 cabbage, 1d.; dripping, ½d.; total, 3d.

Wash the cabbage well and boil it soft in salt and water. Wash the rice and boil it soft and dry. Mash the cabbage well; add it to the rice with the dripping, and pepper and salt to taste. Mix well and serve hot. Good.

Potato Pie.—One-fourth pound suet, 1½d.; onions, ½d.; one-half pound oatmeal, ¾d.; one-fourth stone potatoes, 1½d.; 1 pound flour, 1½d.; one fourth pound lard, 1¼d.; baking powder; total, 6¾d.

Chop the suet very fine, cut the onions small, pare the potatoes very thin, and cut in slices. Take a large pie dish, scatter some suet in first, then some onions, then some meal, and a layer of potatoes, pepper and salt, till all is in. Put potatoes on the top, then cover with a crust made of the flour, lard, and 1 teaspoonfull of baking powder. Bake for two hours in moderate oven.

Savory Meat Pie with Potatoes.—One-half pound liver, 1½d.; 1 pound scrap meat, 5d.; onion, ½d.; 1 pound flour, 1½d.; one-fourth pound lard, 1¼d.; pepper, salt, baking powder; one-fourth stone of potatoes, 1½d.; total, 11d.

Cut the meat and liver into nice thin slices. Chop the onion fine. Put a tablespoonful of flour, a teaspoonful of salt, a teaspoonful of pepper on a plate; then mix, and dip your meat and liver in this. Roll a small bit of onion in a piece of liver, then the liver in a slice of meat, and lay it very lightly in a pie dish, heaping it in the center; add water till the dish is three parts full, then cover.

Cover: Flour, lard, and a teaspoonful of baking powder, mixed well together, with cold water and a pinch of salt; roll to make nice stiff paste. Cover and bake for two hours. Serve hot with potatoes.

Skirt Pie and Potatoes.—One and one-fourth pounds beef skirting, 5d.; pepper and salt, ½d.; baking powder; 1 pound flour, 1½d.; one-fourth pound lard, 1¼d.; one-fourth stone potatoes, 1½d.; total, 9½d.

Beef skirt is very tender and good if nicely cooked. Cut it across in thin slices. Mix a tablespoonful of flour, a teaspoonful of salt, one-half teaspoonful of pepper on a plate, and dip each slice of meat in this mixture. Roll up tightly and place in a dish, keeping it well in the center. Fill three parts full of water, and cover.

Cover: Flour, lard, baking powder, pinch of salt, mixed well together; add cold water to make stiff paste. Bake two hours. Serve hot with potatoes.

Two Dinners from a Sheep's Pluck.—One sheep's pluck, 6d.; 1 pound onions, 1d.; 2 ounces dripping, ¾d.; some sweet marjoram, pepper and salt, ½d.; one-half stone of potatoes, 3d.; total, 11¼d.

Split the heart, cut the lights, and soak in water for an hour. Take them out and cut in small pieces. Put a teaspoonful of dripping in a stew pan with 2 onions cut fine. Let them brown. Add the heart and lights with 2 cups of water, half a teaspoonful of powdered marjoram, let them boil, and keep them simmering for two hours. Serve with potatoes or rice.

Fried Liver.—Cut the liver in thin slices. Cut the onions fine. Put a tablespoonful of dripping in a pan; let it get hot. Add the liver, and let it cook for about ten minutes, then turn it out on a warm dish. Put in the onions, and fry them brown. Mix a teaspoonful of flour and some pepper and salt in half a cup of water, and stir it into the pan with the onions. Let it boil up for a minute, then pour it over the liver.

Two Days' Dinner for a Family.—Ox foot, 5d.; vegetables (cabbage, turnip, carrot, leek, parsley), 2d.; pot barley, 1d.; potatoes 3½d.; cheese, 1½d.; flour, 1½d.; total, 1*s.* 2½d.

First day's dinner, broth, stewed ox foot, and potatoes; second day's dinner, broth, cheese, and potato pie.

To make two days' broth, get a good ox foot, cleaned, wash it well, and put on in 2 gallons of cold water. Boil very slowly for five hours the night before it is wanted, then take it out, and skim all the oil carefully

*Continued from SUPPLEMENT, No. 731, page 11686.

off. After breakfast put on the stock that the foot was boiled in (keeping out one pint); add water to make up 2 gallons; wash the barley well and add. Wash the vegetables very carefully, cut them very fine (grating the carrot), and add them, after the barley has boiled slowly for an hour. Keep the lid close on the pot, and boil slowly for another hour, in all two hours. Salt and pepper to taste.

Ox foot stewed to be taken with potatoes: Cut the foot in nice pieces, put in a saucepan with the pint of stock (if liked, a little of the white part of the leek also). Take 1 ounce of flour, pepper, salt, and a tablespoonful of oil, mix with a little tepid water, make into little balls, and add twenty minutes before you serve on a hot plate, the balls being put round the pieces of foot. Boil half the potatoes, and you will have a good dinner for a large family, taking one half of the broth, and leaving the other to be warmed up next day, and taken with potatoes and cheese pie.

For cheese pie take the other half of your potatoes, pare very thin (as the best part of the potato is next the skin), and cut in slices. Put in a layer of potatoes, pepper, and salt; grate the cheese, put in some, and so on till all is in, then over all put in a large tablespoonful of the oil. For crust take flour and the rest of the oil taken from the foot, and mix with tepid water, a teaspoonful of baking powder, a little salt; roll out, and cover pie. Bake for two hours, and serve hot.

Soup and Haricot of Ox Tail.—Good ox tail, 1s.; vegetables, 1½d.; rice, ½d.; total, 1s. 2d.

Haricot: Separate the tail at the joints, wipe with a clean cloth. Take the root and divide in four for the first day's dinner, put it in saucepan, and let it get nice and brown; be careful not to let it burn. Then add the half of the vegetables (which should be carrot, turnip, and onion), 1 pint of boiling water; let it simmer for four hours. Salt and pepper to taste; serve hot.

Soup: Take the rest of the tail, put on with 3 quarts of cold water, 3 cloves, 1 teaspoonful of mixed sweet herbs, 10 peppercorns, 12 allspice; tie all these in a muslin bag. Let all simmer very gently for three hours. Add the rice, after it has been well washed, and the other half of the vegetables cut very fine or grated, and boil for two hours more with a close lid. Serve hot.

Stewed Hough.—One pound hough, 5d., cut in slices (by the butcher, to break the bone). Take out the marrow, and put it into the stew pan with 2 sliced onions and a teaspoonful of flour. Let it brown, then put in the slices of meat, and let them brown for a few minutes; add half a teacupful of water, some pepper, and salt. Stew slowly for four hours, with lid very close. Tough pieces of meat can be made very palatable by long, slow stewing.

Take 1 pound of the common dry green peas, having soaked them for sixteen hours in water, with a bit of soda the size of a nut; and after the hough has stewed for three hours and a half, add the peas with a tablespoonful of vinegar, and let them stew together for half an hour. Serve hot.

Stewed Steak.—Get 1 pound stewing steak and a piece of suet, which is always given. Chop the suet fine and fry. Dredge the steak with flour, and fry very lightly in stewing pan on both sides. Then add a teacupful of water, boil, then simmer very gently for one hour and a half. Add salt to taste, and half a teaspoonful of pepper. A tablespoonful of flour, mix in water, add, boil, and serve hot.

This is very good, and goes a great way further if you add some vegetables. You can vary the flavor with carrots, onions, parsley, turnips, and sweet herbs.

Collops.—Put a little dripping into a saucepan, let it get quite hot, then put in your minced meat, and keep turning it for ten minutes or so with a fork (if liked, when the dripping is hot, before putting in the meat, add an onion chopped fine and a teaspoonful of flour). When all is a nice brown, add as much boiling water as will cover the meat; close the lid, and stew very gently for one hour. Pepper and salt to taste.

Stewed Rabbit.—Cut the rabbit into eight pieces and fry till brown, add a teaspoonful of curry powder, quarter teaspoonful pepper, half a teaspoonful powdered thyme, some carrot and turnip cut in slices, two gills of water. Simmer (with close lid) for one and a half hours. Mix 1 tablespoonful flour with water till smooth, 1 small tablespoonful burnt sugar, 1 of vinegar, a little salt to taste, add this to the stew, and boil all another minute or two. Serve hot.

Curried Rabbit.—One rabbit, 3 onions, 1 apple, 1 teaspoonful curry powder, 1 ounce dripping, and a little salt. Wash and dry rabbit, cut it up in small pieces, put the dripping in a stew pan, let it get quite hot; peel and chop up the onions, also the apple, fry them till a pale brown; add the pieces of rabbit, and fry them on all sides; stir in a teaspoonful of curry powder, a pinch of salt, and mix well with the meat. Add a teacupful of water, and stew very gently with lid close for an hour and a half. Serve with dry boiled rice for a border round it.

Rice and Cheese with Green Peas.—One pound rice, 1½d.; three-fourths pound dry green peas, 1½d.; one fourth pound cheese, 1½d.; vinegar, sugar, pepper and salt, ¼d.; milk, ½d.; total, 5½d.

Wash the rice and put it on to boil in 2 quarts of water, with a teaspoonful of salt. When soft and all the water taken up, stir in the milk with more salt, if required, and pepper to taste. Grate the cheese (old cheese is best), mix it in, but keep a tablespoonful to put on top of the dish. Warm all up in the pot; then turn out on a pie dish. Put the tablespoonful of cheese on the top and let it brown in the oven or before the fire. Get the common dry green peas, soak them for sixteen hours with a bit of soda the size of a bean in the water. Then boil in salt and water. When soft drain, and add 2 tablespoonfuls of vinegar, 1 teaspoonful of sugar, pepper and salt to taste; shake in the saucepan well. Serve hot.

Indian Meal and Cheese.—One pound Indian meal, 1d; one-fourth pound cheese, 1½d.; dripping, ½d.; total, 3d. Boil the meal for one hour, and let it be very thick. Grate the cheese and add with dripping, pepper, and salt. Serve hot. Good after hard day's work.

Potted Head.—Half an ox head, 1s. 6d. Break up the head, wash, and soak it in water for a few hours. Boil slowly for five hours in enough water to cover it. Then take it out, and skim the fat off the pot. When cold, lay the head on a clean board, and take the meat off the bones. Cut the meat into small pieces, and put it back into the pot. Add a tablespoonful of salt, a tablespoonful of Jamaica pepper, a teaspoonful of black pepper, a pinch of Cayenne pepper, and boil all for half an hour; then put into basins, and let stand till cold and stiff. This, warmed up, will make good dinners for two or three days, with potatoes.

Black Pudding.—One quart of blood and skins, 1d.; one-half pound suet, 3d.; and one-half pound oatmeal, 1d.; one-half pint skimmed milk, ½d.; 1 teaspoonful of mint and a little salt, ½d.; total, 5½d.

Get the blood free from clot. Mix with the oatmeal. Add suet, salt, a tablespoonful of Jamaica pepper, a teaspoonful of black pepper, and a teaspoonful of powdered mint. Warm the milk, add, and mix thoroughly; turn the skins inside out, and wash them well in warm water and salt. Then rinse them well in cold water, and fill three parts full with the mixture. Tie the two ends together; put them in hot water and boil slowly for twenty minutes. While they are boiling prick with a pin to let the air escape. For serving toast before the fire, or fry in a pan for ten minutes.

To Boil Potatoes.—Wash the potatoes clean in cold water, put them in a pot with cold water to cover them, and a tablespoonful of salt; boil from twenty minutes to half an hour. Take a fork, and feel if their center is quite tender; if so, drain off all the water, put a clean cloth over the potatoes in the pot, let them stand by the side of the fire with lid on to steam. When quite dry, take them out very carefully, peel them without breaking, and put them in a hot dish. If the potatoes are watery, put them in boiling water and keep boiling rapidly till done; dry well and it will make them quite mealy.

How to Boil Rice.—Half pound rice, a pinch of salt, a quart of water, and a tablespoonful of dripping.

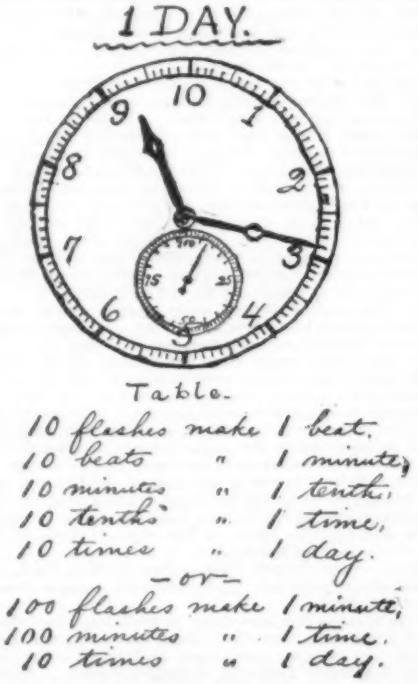
Put on a quart of water; let it boil. Wash the rice well. Throw it into the boiling water with a pinch of salt. Boil for fifteen minutes. The rice must be soft, but each grain separate; drain it in a colander, and shake it well. Put the dripping into the pot, then put the rice back, and let it swell slowly near the fire for ten minutes. Serve hot.

How to Boil Macaroni, and to Make Macaroni Cheese.—Put on a quart of water, let it boil. Add a little salt, then a half pound of macaroni. Boil for half an hour; drain it in a colander. If for cheese, put one cup of milk into the pan, one-fourth pound of grated cheese, a tablespoonful of dripping, a tablespoonful of flour, one-half teaspoonful of pepper, a little salt. Let it boil. Grease the bottom of a pie dish, put in the macaroni. Pour the milk, cheese, flour, pepper, and salt over it, and, last, sprinkle a little more grated cheese on the top. Let it brown before the fire or in the oven. Two eggs may be added in place of cheese, and a teaspoonful of sugar.

(To be continued.)

A NEW TIME NOTATION.

THE following scheme of marking time is suomitted, not with much or any hope of its ultimate adoption, since it involves a change in the mechanism as well as marking of the existing chronometers, but with the venture that it may be of interest, owing to its simplicity. It is based upon and has the advantages of the decimal system and avoids the well known confusion often arising, especially in railway usages, from having in the same day two periods of twelve hours each.



The day is divided into ten equal parts and each of those parts is subdivided likewise, and so on, as shown below.

The table of equivalents is as follows:

1 day	= 10 times	= 24	hours.			
1 time	= 10 tenths	= 2·4	"	= 144	min.	
1 tenth	= 10 minutes	= 0·24	"	= 14·4	"	
1 minute	= 10 beats	= 0·024	"	= 1·44	"	
1 beat	= 10 flashes	= 0·0024	"	= 0·144	"	
1 flash	= 0·0001 day	= 0·00024	"	= 0·0144	"	

The main denominations are the "flash," the "minute" (nearly half longer than the present minute) and the "time." The "time" indicated by the above diagram is three "tenths" past nine, or, more accurately, the time is 9·29, *i. e.*, 29 minutes past 9.

Noon would be at 5, and the day end at 10 or midnight. One "time" corresponds to 36 degrees of longitude, and America need have but two standard times, that of Washington or Eastern time, for all places on or east of the Mississippi, this river thus furnishing a physical instead of an imaginary line north and south, for the change in time; and that of the 36th degree of longitude west from Washington, to be known as western or mountain time, for the remainder of the country.

No traveler east of the Mississippi would then ever need to change the position of the hands of his watch, and one more table of measure would be based on the decimal system.

CHARLES H. RICHARDSON.

Washington, D. C.

CONSTITUTION OF THE CELESTIAL SPACE.

Constitution de l'Espace Celeste. Par G. A. HIRN. Paris: Gauthier Villars et Fils.

THE central fact M. Hirn sets forth and demonstrates in the above-named book is that space in the starry firmament is devoid of matter. He says: "The final conclusion of my book, the summary, so to speak, of every chapter, is that matter in celestial space exists only in a sporadic form, as in distinct bodies, suns, planets, satellites, comets, aeroliths, cosmic cloud, or dust. In a diffused or diluted state it exists only in the nebulæ which are supposed to be still in process of formation.

Except in these nebulæ, space is now completely devoid of matter, or if any remains the quantity is so small that it is no longer sufficient to explain the relation of one star to another, and the phenomena of attraction, luminous or heat radiation, etc. As these relations are facts, they must be accounted for by the presence in space of something which is not matter, by whatever name it may be distinguished. In this assertion there is nothing hypothetical, incomprehensible, or chimerical; we simply state a fact."

In his introduction, forming in itself a considerable volume, M. Hirn uses a method of argument different to that usually employed in works of this kind. He first deduces the physical and philosophical consequences of the following fundamental proposition: The substance that fills infinite space is of a totally different nature to that which we understand by matter. The accuracy of this proposition he proceeds to demonstrate in the body of his work. We, however, will take the liberty of reversing the order adopted by the author, and will peesent first the arguments he brings forward to prove his fundamental position. These arguments we shall merely summarize, omitting all the mathematical demonstrations by which they are illustrated in M. Hirn's work.

If a fluid, however rarefied, existed in the infinite space which encircles the heavenly bodies, it would offer some resistance to the movements of the stars in their orbits, and in process of time the progress of the celestial bodies would be affected by it. With some of them, indeed, such changes of motion could be verified by observations extending over several centuries. The effect of the resistance offered by a fluid substance to the movements of the planets would be shown in their increased rapidity of revolution. On our earth, this acceleration of its revolution would have the result of shortening the year. For if one kilogramme of matter were diffused in 8,600 cubic kilometers, it alone would in 2,000 years diminish the length of the sidereal year by five seconds, and alter the longitude of the earth by 205 seconds, without taking account of any of the other known causes of periodic variation. Such a deviation is manifestly impossible.

In the case of the planet Mercury, one kilogramme of matter diffused in 56,700 cubic kilometers would in a century shorten the duration of the year of that planet by half a second, and in 2,000 years the longitude of the planet would deviate by 1 deg. 58 min. This also is not a fact.

The theory of the moon is more complicated; but the movements of our satellite would certainly be affected by perturbations which could not escape the notice of our astronomers if it encountered in its course one kilogramme of matter disseminated in a prism one kilometer square at its base and equal in height to about three times the distance of the earth from the moon. Phobos, the largest of the satellites of Mars, comes next to the moon, and the comets follow in bearing witness to the absence of any resisting gas diffused in space.

One of the finest chapters of M. Hirn's work is devoted to an examination of the consequences which a resisting medium would have upon the various phenomena presented by the comets. His conclusions are the very reverse of Encke's. The latter astronomer thought that the perturbations in the movements of the comet called after his name proved the existence of a material resisting medium. M. Hirn shows that these perturbations may be attributed to the action of solar radiation, which, by exciting corresponding movements in the cometary mass, causes friction, that is to say, a development of latent heat, and annuls part of the reflex action. He says:

"It is now generally admitted that the tail of the comet is an emanation from the head (or nucleus) of the body. As the comet approaches perihelion, and is exposed to the full force of the sun's rays, the central parts of the nucleus appear to undergo some process of ebullition, and rush toward the sun. But on reaching the periphery they change their course, swerve aside, so to speak, at the circumference, and begin to recede rapidly, as if blown back by a new force in the reverse direction. What is the force which acts in this decisive manner on certain parts of the comet and not on others? Is it heat repulsion, as my friend M. Faye thinks? Or is it electric repulsion, as other astronomers maintain, that is at work? Both these explanations may hold good for the present, and perhaps we shall find that each of them may to a certain extent be true."

That the two causes, heat and electric repulsion, act simultaneously may safely be admitted. But this proves nothing, for the question immediately arises whether even these two repulsive forces together are enough to account for the prodigious effects of repulsion observed in a comet.

All gases, of whatever nature, which exist in the comet when it is in perihelion are congealed when it is in aphelion. Now if there were any resisting medium, the corpuscles that are kept together by the force of attraction would be least acted upon when the comet is in aphelion. In perihelion the cometary mass be-

comes volatile, and the material medium, if there were any, would then act upon it with the maximum of resisting force. But to maintain that a gaseous body, moving so rapidly that it often attains a speed of many hundred kilometers per second, can pass through a gaseous medium, however rarefied, without having its rapidity of motion destroyed by the friction of the gases at the periphery, the whole cometary mass retarded in its course, and the entire star rapidly reduced to nothing, is to maintain a physical impossibility. The mere fact of the forward motion of a comet when in perihelion, without any sensible alteration in bulk, is the most striking refutation of the existence of a resisting medium in infinite space.

Although M. Hirn has drawn the strongest arguments in support of his theory from the mechanism of the heavenly bodies, he has thought good to strengthen his case with other still more convincing proofs afforded by the physical effects of a gas diffused through the stars in space upon the atmosphere of the planets. He begins with a startling fact, which would be the natural result of the well ascertained principles of thermodynamics. "As a consequence of the pressure produced by the motion of the moon, the gaseous medium would attain the enormous temperature of 38,280 deg." without becoming luminous or phosphorescent like the tails of comets.

Further, if the upper strata of the terrestrial atmosphere, which are carried round with the earth as it rotates, and are already in exceedingly rapid motion, met with any resistance, however slight, they would be checked and lag behind the planet in its course, and would finally be irretrievably lost in space. The continued existence of the planetary atmosphere is absolutely irreconcilable with the presence of gas of any kind in space.

The last chapter is devoted to a sketch of the probable future of our sun and of the other stars. After a number of interesting and instructive observations on the temperature of space, the temperature of the sun, its loss in heat and the way in which this loss is compensated, M. Hirn concludes in these words: "The worlds of space are not destined finally and necessarily to be extinguished, even at some very distant period. The constancy of solar radiation, from the time of the earliest data furnished us by astronomical observation, forces us to the conclusion that the sun, after cooling rapidly for a lengthened period, has reached a condition of radiation which, if it varies at all, undergoes such slight changes that till now not the least modification in its heat has been observed. Probably, therefore, some compensating phenomenon is associated with the loss of heat by radiation, and causes the temperature of the central orb to remain the same, or at least to fluctuate only within limits so narrow that they have escaped our notice."

The original cause of this phenomenon of compensation is still unknown, although the existence of the phenomenon itself is difficult to deny. M. Hirn ventures to express an opinion that it "may be based upon both the peculiar structure of the solar heat centers and upon a certain property of the intervening dynamic element, which has hitherto, by some strange mistake, been identified with matter having weight in space."

These words are taken from the introduction to the book, and bring us back to the subject with which it deals. In fact, it is the introduction which gives at great length the consequences of the fundamental proposition; it is not diffused matter which fills space, and establishes the relations between the heavenly bodies. The body of the work we have been rapidly analyzing is devoted to the mathematical demonstration of this proposition.

If it is not matter, what is it that fills space, and brings one celestial body into relation with another across the vast abyss of space? For even Newton recognized that an unknown something existed when he said, alluding only to the force of attraction, and leaving unnoticed light, heat, and electricity: "To maintain that gravity is inherent in and an essential part of matter, in the sense that one body can act upon another at a distance, across space, without some intervening medium, determining or conveying this reciprocal action, seems to me so great an absurdity that those who fall into it must be absolutely incapable of all philosophic discussion. Gravity must be caused by some agent acting continually according to certain laws. But is this agent corporeal or incorporeal? I leave the reader to determine."

Mr. Hirn has solved Newton's question by the light of the new science of elementary force, which had its origin at the same time as the mechanical theory of heat. For reasons already briefly indicated, he does not hesitate to reply. "No; this agent is not corporeal; it is an intermediary agent, to which we may give the name of dynamic element. And this element is an objective and physical reality, quite as much as the element of matter."

The author does not decide the question how the dynamic element, taken as a whole, acts upon the element of matter, nor does he seek to determine the constituent essence and being of these two elements.

He contents himself with verifying their existence from a scientific point of view, without making any demand upon our credulity. On the contrary, he invites the reader to lay aside, as he has done himself, all preconceived ideas, and to give up every scheme which is not based entirely on those known facts that we are obliged to admit, whether or not we understand them.

The dynamic element fills infinite space, and the worlds are immersed, so to speak, in this medium; the atoms composing the heavenly bodies are bathed in it, and all space between is filled with the same element, often, however, profoundly modified in its manifestations. The whole together constitutes the physical universe, the history of which is the result of the action of these two elements, the dynamic and the material, upon each other.

Is the dynamic element simple or complex? The same question may be asked about the element of matter, and both can be answered in the same way. Just as there are various substances which cannot, as far as we know, be transformed one into the other, so the different forces cannot be transformed into each other. But according to a well-known law of equivalents they can be substituted for each other, and here arises another question which must be answered. Is the presence of matter necessary, in order that these forces may be substituted one for the other? Or can the phenomenon be effected by a direct and specific action of the dynamic element itself?

If we start from well established facts, we may assume that the answer will not always be the same, but will vary in different cases. The labors of MM. Weber and Kohbrauch, and the more recent researches of M. Blondot, have tended to demonstrate that direct relations, without intervening matter, exist between radiated heat, light, and electricity. On the other hand, it seems as if, where the force of gravitation is at work, the preliminary action of this force upon matter is necessary to produce the phenomena of heat and electricity. But all this, as we have already said, is still greatly matter for conjecture.

If, however, the presence of matter is not indispensable to produce the phenomenon of the substitution of one force for another, it may on the other hand be safely asserted that even the most apparently insignificant phenomenon cannot take place without the intervention of an ambient dynamic medium. It is when they lose sight of this necessary fact that philosophers are misled in explaining, for example, the phenomenon of friction. Starting from the idea that heat is a vibratory movement of the atoms composing a body, friction is supposed to be caused by exciting these vibrations, much in the same way as a bow sets in motion the sonorous vibrations of a violin string. M. Hirn, who sees facts as they really are, offers quite a different explanation. Friction, he says, continually disturbs the relative position of the atoms toward each other, and destroys the true equilibrium of the electric force; the presence of heat is merely a concomitant phenomenon, that is to say, necessary but consecutive. "All these phenomena which we think completely localized, are not really so; they are connected with, and continually depend upon, the ambient medium. . . . If there is an expenditure of force in one place, some modification in the general condition of the dynamic medium must, under one form or the other, take place elsewhere."

It is impossible to describe the constitution of celestial space without entering upon the question of the plurality of worlds. M. Hirn handles it skillfully in the powerful light of the discoveries of modern science. He reduces to certain purely experimental data the conditions without which organic life on any world is not possible. Thus the presence of water in a fluid state, an atmosphere composed of oxygen, carbonic acid, and azote, and a temperature between the limits of 0 deg. and 200 deg. Cent. are absolutely essential to the existence of organic beings—as we know them—in a celestial sphere. It follows therefore that a heavenly body would be habitable if the heat it received and the heat it gives out were equalized, so as to bring its temperature within the above named limits, provided the component elements of its atmosphere were suitable.

What is the temperature of celestial space devoid of matter? is the next question. What is the temperature of the moon and planets? Many scientific data are needed to solve these problems, and they must be skillfully classified before positive results can be deduced from them. If a thermometer were placed in space, completely protected from solar radiation and exposed only to radiation from the stars, it would stand at about absolute zero (273 deg. below zero Cent.); if it were not protected from solar radiation, it would mark about 50 deg. absolute, or — 223 deg. Cent. if at the distance of the earth from the sun. A heavenly body rotating on its axis and revolving through space receives, at the earth's distance, 30 calories per minute per square meter of its surface directly acted upon. But as it radiates in the same proportion and at the same time that it receives heat, it loses a part, which is diffused through space. If the body possesses an atmosphere capable of acting as a protective covering, this process of gain and loss of heat will suffice to maintain a mean temperature suited to organic life. In such a case the protective atmospheric wrapping must be of a certain density. We know that the moon has passed through a phase of existence when it was able to maintain such an atmosphere by its own heat, but it had not sufficient bulk to preserve these atmospheric conditions for long. The temperature of the moon is now probably below — 223 deg. Cent., and its atmosphere wholly congealed, and it is neither inhabited nor habitable.

Other planets in our solar system are, however, known to be provided, at this very time, with those organic conditions which are wanting in our satellite. Only one question, therefore, remains. Is it probable that the present habitable state of our globe will continue? Are the conditions of this process of equality between the gains and losses of heat destined to last indefinitely? In other words, will the sun always furnish us with the same amount of heat, or will it one day be extinguished?

Many generations will certainly succeed the present before this question becomes of imperative moment. Nevertheless it deserves discussion, and if possible, an answer.

Now we have no grounds for affirming that solar radiation has diminished during 4,000 years in any appreciable degree. If the sun were really growing colder its temperature would fall at least 13°36° C. annually, and we should be forced to assign to it a temperature of many millions of degrees to explain the prehistoric data relating to the presence of organic life upon the globe. The explications which have been hitherto given to account for the duration of solar radiation are inadequate. Everything tends to show that the sun has been receiving from some source as yet unknown a quantity of heat equal to the amount it loses by radiation, since the time when, by studying its definite mean temperature, we assume that this process might have begun.

The process has not been always going on. "By analyzing and carefully comparing facts," says M. Hirn, "we perceive that the present state of the stars cannot be identified with their original state. At first the phenomenon of loss of nebular heat by radiation stood alone; but by degrees, and after the formation of the suns, another phenomenon of compensation was added to it. So that we can no longer look upon the sun and stars merely as highly heated bodies, which are gradually cooling, and destined to fall some day, after a longer or shorter lapse of time, to absolute zero.

"This phenomenon of compensation, which has, by slow degrees, and as we think completely, counteracted the effects of the loss of heat in the central bodies, must have originated both in the peculiar structure of these bodies and in a certain property of the dynamic or intermediary element which has hitherto, through some incredible mistake, been always identified with the matter having weight.

"It is with the utmost reserve," M. Hirn says, "that I offer the above statement, not as an explanatory hypothesis, but as my own personal opinion. The day may come when some great and unexpected discovery, touching the properties of the dynamic element, the very existence of which has hitherto been denied, will turn my guarded statement into an actual truth. Till then I shall myself only consider it as an opinion."

We have analyzed this book too summarily, we fear, to make the reader understand its full bearing, but M. Flaye, when presenting it to the Academy of Sciences of the Institute of France, said: "Assuredly it is one of the most interesting and original works of modern times." It is unnecessary to add anything to praise so great, emanating from a scientific man of such high standing.—*Engineering.*

THE ORBIT OF SIRIUS.

By J. E. GORE.

THIS is a paper of interest. From it is learned the fact that the components of this wonderful binary are now approaching their minimum distance, which is becoming rapidly very difficult to measure even by the aid of the largest telescopes. The companion was discovered by Alvan Clark in 1862, and Mr. Gore has collected all the known measures since that time, and from them deduced the following elements:

P = 58·5 years	Ω = 49° 59′ (1880·0)
τ = 1896·47	λ = 216°18′
e = 0·4065	a = 8″·58.
i = 55°23′	μ = — 6″·156.

The method used was to plat all the observations (corrected for precession to 1880·0) and draw the interpolating curve and the apparent ellipse in the usual way, and then compute by Professor Glasenapp's method the coefficients of the general equation. These values were substituted in Kowalsky's equations, from which the geometrical elements of the orbit were found.

With Gyldén's parallax for Sirius the above values of P and a give

Sum of masses = 26·298 (sun's mass 1).

Mean distance 44·45 (earth's mean distance from sun = 1). According to the ephemeris, the minimum distance of the components will occur in 1893, with a value of 3″·23, and a position angle of 310°·88.—*Sidereal Messenger.*

THE CENTRAL PARK OBELISK.

A COMMITTEE of experts have lately been making a close examination of the obelisk in the New York Central Park, which has been reported to be crumbling away. The possibility that the stone lacks integrity from having been subjected to fire in its original position in Egypt, suggested in the following statement of Mr. William C. Prime, will not, certainly, tend to allay the apprehensions which have been felt as to its future:

Some general facts in the history of this obelisk are well known. It was one of many which stood at Heliopolis, a city once situated a few miles north of the present site of Cairo in Egypt. From the inscriptions on it, it is certain that it was standing at Heliopolis more than three thousand years ago. It was carried thence to Alexandria and erected near the seashore, in front of the Sebastion, or Cæsarem. It remained there until it was brought to New York and placed where it now stands. This obelisk, like the many others of ancient Egypt, was originally cut from the granite rock at the first cataract of the Nile, and thence floated down the river to Heliopolis. But of its early history at Heliopolis, where it remained so many centuries, little is known, and that little seems to be forgotten.

About B. C. 525 the Persian Cambyses invaded and conquered Egypt, devastating the country with fire and sword. Mighty works of the ancient days were everywhere destroyed. Heliopolis was almost erased. Strabo, the geographer, visited Egypt B. C. 24. His accounts of his personal observations during his extensive travels are among our most valuable sources of historical information. In Book XVII., 1.27, he says:

"There, too, is Heliopolis, situated on a large mound. . . . At present the city is entirely deserted. It has an ancient temple constructed after the Egyptian manner, bearing many proofs of the madness and sacrilegious acts of Cambyses, who did very great injury to the temples, partly by fire, partly by violence, mutilating in some cases and applying fire in others. *In this manner he injured the obelisks*, two of which that were not entirely spoilt were transported to Rome. There are others, both here and at Thebes (the present Diospolis), *some of which are standing, much corroded by fire, and others lying on the ground.*"

I have italicized a few words, which sufficiently indicate the importance of this item of history. Strabo states in what condition he saw the obelisks. Whether the New York obelisk was one of those then standing, or one of the fallen, we do not know. It was removed to Alexandria soon after Strabo's visit. It has often been remarked as an inexplicable fact, while the obelisk was standing at Alexandria, that it was badly corroded and the inscription partly illegible on the side not exposed to the sea. It is hardly to be questioned that this ancient destruction of the surface was due to the fires of Cambyses, before the stone was transferred to Alexandria. It is probable that when so transferred and erected in front of the Sebastion, the best preserved side was placed in front, facing the sea. That the monolith was once subjected to severe fire, especially affecting the lower part, and more intense on one side, seems very probable.

That the obelisk now in the Park, especially the lower portion of it, was pretty thoroughly baked by the invading Persians admits of little doubt. Whether this fact is worthy of notice now, in considering the influence of our atmosphere and climate on it, with reference to surface or internal disintegration, must

be left to chemists and mineralogists. The serious question is whether the disintegration which has certainly resulted in the crumbling away of large quantities of the surface is confined to the surface, or whether the interior of the stone is suffering. It would be a sad error to confine attention to the external complexion and condition of the epidermis, and afterward discover degeneration of the heart.

INDELIBLE IMPRESSIONS FROM MAGNOLIA LEAVES.

The American *Pharmaceutical Journal* states that the leaves of the sweet bay (*Magnolia glauca*) possess a property that is not generally known, viz., that if a fresh leaf be placed upon linen, and any word or name be traced with some pressure upon the leaf, the linen will receive an impression, which is at first of a grayish green color, but which ultimately becomes gradually darker, and does not disappear upon washing.

MINA LOBATA.

AMONG annual twining plants this is probably one of the most distinct introductions of recent years, and a valuable one, too, as the plant is of a high order of merit. As advised by the writer of a previous note upon it early in the season, I placed stout branches to our plants, and they have almost covered them with twining shoots. The plant has sharp-lobed vine-like leaves, and the flowers are borne in a raceme upon one side only.

In the bud state the flower is long, pointed, and of a red color, but ultimately the expanded blossom becomes of a creamy hue, with conspicuous protruding stamens of the same color. The blooms are pretty and remain fresh for several weeks after they have fully opened. Three plants were raised from a packet of seed, all had the same treatment, and were planted against the same

MINA LOBATA, SHOWING HABIT OF GROWTH.

wall, but, curiously enough, while all have made a similar amount of growth, one only is at present flowering, and it is so free that at a short distance it has been mistaken for a scarlet runner bean.—*The Garden.*

TOBACCO CULTURE IN CUBA.

CONSUL EHNINGER, of Cienfuegos, in a report to the state department on the river Arimao tobacco in Cuba, says:

In order to get some data respecting the tobacco culture, I addressed by letter one of the small planters (there are no large plantations), and beg to subjoin a translation of his replies to my questions:

The seed is sown broadcast from about the 15th of August to the 8th of September in a sheltered piece of ground to form the nursery ("semillero"); the plants are left to attain a height of 4 in. No fertilizers are used, the land being sufficiently rich. To prepare the land for planting, all brush, grass, and weeds are removed, and the ground is plowed four times and afterward furrowed to receive the plants. The plants are taken from the nursery in the morning and planted in the evening of the same day. This has been shown by experience to be the best way. Care must be taken to keep the ground free from weeds and to prune the tops of the plants, in order to make them spread; also, the suckers from the roots are to be removed. The pruning is done with the nails of the thumb and forefinger. Care must also be taken to remove the insects which attack the plants. The natural enemies of the plant are the *cachazudo* (our tobacco worm), the *babasa* (a slimy slug which leaves a trace on the leaf and destroys it), the *Cogallero valador*, and the *mariposa* (a butterfly produced by the former, which lay its eggs on the leaf and destroys it). These insects have to be picked off by hand and destroyed as fast as they appear, giving much work. The first cutting is made from three to four months after planting, varying according to circumstances; the other cuttings, from thirty to forty days after the first. After cutting, the leaves are hung on poles 12 ft. long, placed horizontally on forked sticks, and left in the open air for a day or two (not, however, during the night or in rainy weather, as any drop of water falling on the leaf is injurious to it). After this the poles filled with leaves are taking to the drying house and placed horizontally to cool for twenty-four hours. At the end of this time the poles are placed as close together as possible and left so for three days. This is called the first heating ("calentura"). After this the poles are separated again to allow the leaves to cool. The tobacco is left on the poles a sufficient time to become perfectly dry, the length of time depending on the weather. In making the heaps preparatory to packing, a time is chosen when the leaves are softened by the atmosphere, and the leaves are then taken off the poles and placed in a heap in a sheltered spot. A preparation is then made of tobacco stems left in water until fermentation takes place, and with this liquid each layer of leaves is sprinkled before another layer is placed. The tobacco is packed for transport in bales made of the fine bark of the top of the palm tree and tied with ropes made of the majagua bark; in each bale fifty, sixty, or eighty bunches of leaves are placed. The tobacco is assorted into seven classes, from first to seventh class. The ruling prices are from $30 to $44 the horse load (four bales), without choice. Sales are made to Cienfuegos, Havana, Santa Clara, Espuanza, and Sagua. The crops have of late varied from 5,000 to 6,000 bales. One man can attend to 15,000 plants, and in a caballeria (33 acres) 250,000 plants may be raised. No calculation can be made of the area in cultivation, as all are small farmers and raise but little. There is room for much more cultivation. By mules and carts the crops can be taken to Santa Clara, Espuanza, Ranchuelo, Cruces, and Cienfuegos, and from these points there are railroads. The prices are, for hauling, $1 or $2 per horse load (4 bales), according to the distance. This is generally on the buyer's account.

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